FOOD AND THE FAMILY

V. H. MOTTRAM

FOOD AND THE FAMILY

FOOD AND THE FAMILY

BY

V. H. MOTTRAM

M.A.

LATE FELLOW OF TRINITY COLLEGE, CAMBRIDGE,
PROFESSOR OF PHYSIOLOGY IN THE UNIVERSITY OF LONDON

London

NISBET & CO. LTD.

22 BERNERS STREET, W.1

First published in 1925.

Printed in Great Britain
by The Whitefriars Press, Ltd., London and Tonbridge.

To
BRIAN & KAY

CONTENTS

CHAP.		PAGE
	Introduction	ix
I.	What Food can do	15
II.	Some Food Fads—For and Against. .	35
III.	Food: Its Nature and Functions . .	53
IV.	Food and Energy	109
V.	The Daily Ration	121
VI.	Scientific Economy in Food . . .	149
VII.	Meals and the Order of the Courses .	167
VIII.	The Dangers of Modern Foodstuffs .	193
IX.	Some Foods Considered	208
Appendix I.		
	Percentage Composition and Relative Costs of Common Foodstuffs . .	222
Appendix II.		
	Summary	226
Index	. . . . .	229

INTRODUCTION

NO topic rouses either more earnest or more frivolous conversation than food. Probably the frivolity is a cloak to an interest in food felt to be undignified, and either we are naïve and earnest or sophisticated and frivolous. Certainly, in the writer's experience, no wittier conversations have been heard at the High Tables of the Ancient Universities than those provoked by food. One don, a historian whose research confirms his view, hopes that his epitaph will read "HE TOOK HIS FOOD WELL." The traveller, too, knows the anguish of being robbed of his favourite food, and none but the cosmopolitan can smile at the anger of the pious Briton in Rome deprived of his breakfast bacon; or at the nervous irritation of the American trying to persuade a Chester hostelry to provide him with iced tea. Like it or not as we may, the fact remains that food is an interest in life which begins earlier than any and outlasts all others. As a result many are the books about food, though mainly in praise of this or that style of cooking or of this or that food fad. Some there are which are written only for the scientific reader and need extensive interpretation to make them intelligible to the lay reader.

This book is not intended for the gourmet, though there is one chapter which may confirm him in his ways. Nor is it intended for the advanced student of food and its properties, though the average college undergraduate, who does not mind mixing grave with gay, may find it of considerable use in his studies. The main function of this book is to present to the lay reader, in terms as intelligible as they may be made, the broad outlines of the results of modern scientific research into the values of food-stuffs, with especial reference to economy in food compatible with health. There is a whole library of knowledge on the subject of food which needs translation into ordinary terms for the ordinary householder and for the student who is on the threshold of the subject. To attempt to do this is the purpose of this book.

This does not mean that there will be no difficulties for the lay reader.[1] Rarely is there anything anywhere worth while which is easy of achievement. Sauce and peptonise as he may some of the main dishes he has to serve, the writer of this book admits that one or more courses will need some effort in assimilation. But just as a hungry man may bolt some of the tougher morsels of his meal and trust to his less consciously used stomach power, so the lay reader is advised to swallow sundry portions of this book unmasticated and trust to an unconscious

[1] *E.g.*, Chapter III.

power of assimilation. Probably by the time he has reached the end of the book the solid flesh will have melted and the opaque become transparent.

It has been impossible not to anticipate at times in the earlier chapters some of the work more fully elaborated in the later chapters. For such readers who are innocent of, or have forgotten their chemistry the following rough definitions are here given.

Acids.—These are substances which taste sour, have the power of dissolving metals, and change the colour of sundry vegetable and other dyes. Thus acids change blue litmus to red. Acids known to most people are acetic acid, which gives the sour taste to vinegar; oil of vitriol, or sulphuric acid; oleum, or fuming sulphuric acid; citric acid made from lemons; tartaric acid made from wine-lees and used in baking powder; and carbonic acid gas, a substance breathed out from the lungs.

Bases.—These are compounds of metals formed when a metal combines with the oxygen of the air. They have the property of quenching the acidity of acids, and their union with acids produces a *salt*. Simple examples are lime, the result of the union of the metal calcium with oxygen; magnesia, of the metal magnesium with oxygen; iron rust, of iron with oxygen.

Lime combines with carbonic acid gas to form calcium carbonate, or chalk; magnesia with sulphuric acid to form magnesium sulphate or Epsom

salts ; and iron oxide with citric acid to form ferric citrate. These are salts. Common salt is sodium chloride, or the result of the union of sodium oxide with hydrochloric (or muriatic) acid.

As a rule salts do not change the colour of litmus (though there are exceptions) and are therefore termed *neutral*.

Alkalis are the result of the solution of a base in water. They turn red litmus blue and such a solution is termed *alkaline*.

Proteins are complex chemical substances containing about 17 per cent. combined nitrogen, an element found free in the air. Nitrogen is essential to life, and the eating of proteins is essential to animal life. Plants manufacture them even from the free nitrogen of the air ; but animals have to prey upon plants or other animals for their proteins. Proteins are found in nearly all foodstuffs but in very different percentages. Examples of nearly pure protein are the white of egg and the lean of meat.

Fats are oily or greasy substances formed by the union of glycerine and fatty acids. Examples are butter, mutton and beef fats, olive oil, etc.

Carbohydrates are substances which contain the elements carbon, hydrogen and oxygen, the last two being in the same proportion in which they are found in water, namely two parts of hydrogen to one of oxygen (H_2O !). Examples are starch and sugar.

ROUGHAGE.—Indigestible material, such as plant fibres found in food.

VITAMINS.—Mysterious substances of, as yet, unknown chemical composition, present in very small amounts in many, but not all, foods. They are essential to life.

Armed with these few definitions, which are perhaps too crude for the technical reader, the average householder, for whom this book is primarily intended, should have no difficulty in understanding its main argument. The practically minded will find their pabulum in the various appendices.

Acknowledgments are due to Dr. Graham Lusk, the "onlie begetter" of one part of the problem, to Dr. Robert Hutchison, whose book "Food and the Principles of Dietetics" is a mine of information, and to the author's colleague, Dr. Gladys Hartwell, whose work on nutrition is frequently quoted in the text of this book.

V. H. M.

HOUSEHOLD AND SOCIAL SCIENCE DEPARTMENT,
KING'S COLLEGE FOR WOMEN, CAMPDEN HILL, W.8.

FOOD AND THE FAMILY

CHAPTER I

WHAT FOOD CAN DO

"Nutrition is the Foundation of the Public Health."

"He has been ill—and so he banyanned upon lobster salad, and chocolate cream, washed down by deluges of champagne."

SO much magic has been coupled with the eating of food, both in primitive times and in our own more sophisticated days; so many claims have been made for the wonderful results of eating this or that patent food; so many ill results are supposed to follow the consumption of this or that article of diet (*e.g.*, white bread), that it is reasonable thus early in this book to discuss the undoubted effects of the eating of poor or good foods.

Food, though it is no panacea for the multitudinous ills of mankind, can do much, both to make or mar the human body. This is particularly so with the young growing child. All the material from which his body is developed has to come from the food he eats. Seeing that he doubles or trebles his weight

in the first year of life, and increases it twentyfold by the time he reaches adult stature, it will be seen that food has much to accomplish. Naturally, if the food be poor, the growth and physique will be poor ; and if good, the results will be good.

Food and Health.—For the adult there is no sign comparable to that of growth in the young which tells him whether or no his food is " doing him good." True, there are various subjective symptoms such as " that tired feeling," discontent with the world, gloom and irritability, or their opposites, well-being, cheerfulness and content. Sometimes they are attributed to this or that food—the lobster salad and chocolate cream—and not to the combination of those foods with the other courses of the menu and with the drinks. Long ago it was pointed out that the proof that mince pies in themselves are indigestible needs an exceedingly long and tedious course of experimentation. Yet we all are certain that we know exactly the ingredient of a dish which caused our indigestion and try the temper of our household by giving orders that it shall be excluded from the menu, until there is nothing reasonable left upon which to make a meal.

As a general rule, such " certainties " of subjective " knowledge " should be distrusted, and are more the result of worrying about food than of eating it, though there are a few unfortunate people who have

idiosyncrasies of diet. Some folk develop a rash after eating strawberries, grapes or shellfish, just as there are others who get hay fever or asthma when the plane trees or the grasses are flowering. Such people need special care ; but the majority of us can eat the average diet of any country without being a penny the worse.[1] If it were not so, it would be amazing that there is such diversity of tastes existing side by side in this world with such comparative equality in efficiency. One family or race are predominantly vegetarian and others flesh-eating, yet there is apparently little or nothing to choose between them in physique or efficiency. The fact is, that any well-chosen, all-round dietary is satisfactory for adults, though nowadays the epithet " well-chosen " has to be emphasised. Modern economic conditions have narrowed our choice, for variety costs money, while modern methods of manufacture have destroyed or refined away important constituents in our foods. Those of the highest price and apparently the best quality are sometimes less valuable than those of lower price and quality.[2] The danger is that though we pay well for commodities we may miss from our diet traces of ingredients necessary to the best health. A knowledge of the

[1] We have all met and hated the persons who, with a tone of conscious rectitude and insufferable worth, assure us that they " never touch " some specified food. It is a dietetic vice, not a virtue, to exclude things from your diet.

[2] See Chapters III. and VII.

scientific discoveries about food is essential to the modern householder.

To combat any doubt of the possibility of altering the state of health of a person on a normal diet by means of food, let us give one natural condition in which a change of food makes all the difference in the world.

One of the most unpleasant concomitants of expectant motherhood during the first three months, and sometimes extending beyond that date, is "morning sickness." A woman in that state experiences a lack of interest in food, headache, depression and often nausea and sickness, especially in the early morning. Hence comes the usual name for the trouble. This is frequently spoken of as inevitable. Indeed, it is taken as an index of the vigour and health of the coming child.

To-day there is strong evidence that this is by no means the truth. Morning sickness can be completely eliminated in 75 per cent. of women, and greatly alleviated in the rest, simply by altering the food.

When the fat in the food bears more than a definite ratio to the starch and sugar, the fat is incompletely utilised in the body and gives rise to substances known as the acetone bodies. These accumulating in the blood produce headaches, malaise and sickness. This happens in the early stage of motherhood, not because in the diet there is too much fat in proportion to the sugar and starch in the food judg-

ing from a normal person, but because the sugar is drawn away from the blood to the uterus, with the result that there is not enough sugar left to take care of the fat. Acetone bodies are therefore produced in quantities, and result in morning sickness.

Obviously the way to treat such an unpleasant state of affairs is to alter the diet in the direction of decreasing the fat and increasing the starch and sugar. When this is done, morning sickness dwindles and disappears. The simplest way in which to effect the change is to take dry toast, biscuits, jam and honey[1] instead of bread and butter; tea and lemonade heavily "sugared" with the tasteless "sugar of milk"[2] instead of *café-au-lait* and cocoa made with milk; and lean meat and fish, such as cod, whiting, plaice and sole, instead of fat meat, bacon, salmon, herrings, sardines and mackerel. Particularly the last thing at night, biscuits and lemonade are advisable.

Such treatment has worked wonders in the numerous cases in which it has been adopted, showing how a simple knowledge of foodstuffs, their composition, and the way in which the body deals with them, can ward off one of the bugbears of expectant motherhood.

[1] Perhaps this explains why—

"The Queen was in the parlour
Eating bread and honey."

If so, the first lines of the rhyme take on a new meaning.

[2] This commodity is easily purchasable from any good chemist.

Though we cannot all be mothers, we may all suffer from an accidental production of acetone bodies as the result of faulty combustion of fat, The medical man calls it a ketosis, and we call it a bilious attack (though it may have nothing to do with bile) or a sick headache. Headaches and sickness may arise from many other causes, such as constipation or appendicitis, but a ketosis is a common cause, especially in children. In the earlier stages there is irritability and bad temper, later lassitude, gloom, sickness and headache. The best way tentatively to treat such a state is to cut out all fat from the diet, including such a food as milk, which is rich in fat, and to eat biscuits, toast and sugar. Often a debauch of rather cheap sweets made of boiled sugar will clear up such an attack and obviate a visit to the doctor. While a craving for sweets may indicate a perverted taste, it may also indicate an instinctive desire for sugar to deal with a faulty combustion of fat.

Deficiency Diseases.—The best evidence of the value of a well-chosen diet can be gathered from the results of living too exclusively on one type of food. Very few of us have suffered in this way in such an outspoken form that it merited the name of disease. But the suspicion is growing in the minds of medical men that at times we may be on the verge of trouble ; that owing to careless catering we may be missing one of the valuable constituents of a mixed diet and

so suffering "dis-ease" in a subacute form. At any rate the study of the acute results of omitting this or that constituent from our food will help us to understand what food can do in maintaining health, and what foodstuffs are essential and what supplementary to a perfect diet. Such diseases are called deficiency diseases and include goitre or Derbyshire neck (due to an absence of iodine in our food), green sickness or chlorosis (due to an absence of iron), rickets (due primarily to an absence of vitamin A), beri-beri (due to an absence of vitamin B), scurvy (due to an absence of vitamin C), and pellagra (due to an absence of first-class protein).

For our present consideration we will choose pellagra, leaving the discussion of the other diseases enumerated to a later chapter [1] where they can be more conveniently considered.

The term PELLAGRA means "rough skin," one of the more prominent features of the disease so-called. It is met with in Italy, Spain, and the southern states of the United States of America, *e.g.*, the Carolinas, Georgia and Louisiana. The skin of the backs of the hands, the elbows, the nape of the neck, the knees and the back of the foot becomes scaly and pigmented. It cracks and festers. Accompanying this there is a profound digestive disturbance, and the patients are a little "queer in the head." Sunlight, so plentiful in the countries where pellagra

[1] Chapter III.

occurs, causes an intense and unendurable burning of the scaly skin. If not taken in time the disease may kill, and so prevalent was it becoming in the southern states mentioned above that the United States Government appointed a commission to investigate it.

The sum of the evidence is strongly in favour of the disease's being due to the poor quality of the protein in the sufferer's diet. Wheat protein and maize protein form a large part of the protein ration in the countries where this disease occurs. The remedy is a good mixed diet, with plenty of eggs, milk and meat—*i.e.*, a diet which contains good animal protein.

The question naturally arises, "Why is pellagra not seen in England?" There must be families in the slums whose food is no better in animal protein than that of the poor in South Carolina, Georgia and Louisiana. Poverty drives people to eat the cheapest of food—viz., bread—and they exclude from the dietary the more expensive, such as eggs, meat and milk. The protein of bread is not in the same class as the animal protein, and so the very poor must be living largely on second-grade protein. Therefore we might expect to meet pellagra in our slums.

Possibly the reason why we do not meet it is the gloominess of our climate, made more sunless by our smoky fires. Sunlight aggravates pellagra and may even be necessary to its development.

Possibly, too, pellagra *is* present in a very mild form and unrecognised as such. Such a possibility must not be overlooked either when considering this disease or any other of the deficiency diseases. But whether or no pellagra is likely to appear in Great Britain, *the evidence of its cause and cure points, as does the evidence from all the other deficiency diseases, to the value of a good all-round mixed diet.*

Nutrition and Growth.—A necessary corollary of the fact that all growth comes from the food we eat is that the effects of good and bad diets can be best seen in the growth of children. Probably there is no parent but wishes to see his children healthier and better grown than the average. The statesman deplores the fact that there are so many undersized and unhealthy people in Great Britain. During the War it was a shock to the conscience of the nation that so many of the populace had to be classed as C3. Such deficient stature and health is primarily due to poor feeding in infancy, youth and adolescence.

As proof of this, experiments made under the auspices of the Ministry of Health and the Medical Research Council may be cited. A well-known charitable institution was chosen where the youthful inmates are segregated into houses, all receiving the same basal dietary. Two houses were taken in which the average ages of the children were the same. Every child in one house was given a pint of milk

extra per day, and, though there was little need, it was seen that he drank it. To each child in the other house an amount of bread, equivalent in energy-producing value to the pint of milk, was given. Independent witnesses called in, who had no idea of the nature of the experiment being made, or indeed that an experiment was being made at all, unhesitatingly agreed that the children who received the daily ration of milk had, during the course of the experiment, astonishingly gained in stature, health and physique when compared with those in the other, the " control " house.

The experiment is still in progress—it has already lasted more than two years—but it is not premature to draw conclusions from it. For us, for the citizens and statesmen of this country, the main conclusion is that the *quality* [1] *of the food eaten by growing children determines their physical welfare.* Nutrition is the foundation of the public health.

Experiments on this scale are both difficult and expensive to carry out. But confirmation of the results so far obtained comes from observations on different classes of the community and from observations upon the growth of animals.

A committee appointed by the Medical Research Council reports that in mining communities where

[1] As will be seen in a later chapter, milk is a better food than bread, though not so cheap. Its proteins are of A1 quality, while those of bread are second rate.

the daily ration of food is below the mean ration accepted as necessary by physiologists as the most advisable (see Chapter IV.), the heights and weights of the children receiving this diminished ration were below the average of all children from the same geographical region.[1]

Another mission, financed by the Medical Research Council, to Vienna reached confirmatory conclusions. After the Treaty of Versailles the depreciation of the exchange in Austria produced widespread poverty, with the consequence that people even of the intellectual classes could not get enough food for their children, and the hospitals were overcrowded with them, suffering from all manner of troubles. They were undersized, rickety, or tuberculous. Applying the knowledge gained from experimentation on animals, which had, as yet, owing to the War and the prohibitive cost in Austria of English and American scientific journals, not percolated to the Viennese physicians, almost miraculous changes were produced in the condition of the patients. Growth was improved, rickets cured, and tuberculosis alleviated. The insistence of the modern researcher in nutrition on the need for an all-round well-balanced dietary was fully substantiated. It was shown that nutrition was fundamental to health.

[1] With some justification, the small stature of boys and girls who were adolescent during the years 1917 and 1918 is accredited to the war diet of the time.

Experimental Tests.—In all experimentation on foods and food-values when carried out upon human beings, there are bound to be ragged ends which the physiologist could wish might not be there. However determined one may be that only children of such and such an age shall be admitted to the wards of a hospital where the effects of different foods are being tested, humanitarian sentiments step in and upset the results. You cannot refuse to admit some urgent case because the child is not of the age you have decided to work upon. And as soon as one dietary shows itself a slight improvement upon another, in spite of the fact that your scientific case for it is not proven, you put everyone upon the good diet and ruin your experiment. None but a callous god can experiment with human beings.

This is why experimenters in nutrition work with animals. They can choose their stock and see that it is all healthy and comparable with one another. Compassion does not lead them to choose weakly and undersized material for experimentation. The experiment can be continued as long as one will, and, more important, animals grow at such a rate and reach maturity so soon that a real experiment, carried out as a man of science would like, does not last a lifetime. The white rat is an extremely useful animal for the purpose. It is small, cheap to feed, can be bred in large numbers ; it grows very rapidly, and reaches maturity in about fourteen weeks.

Moreover, it is omnivorous—it eats all sorts of food—like man, and very many of the results obtained from strictly scientific experiments upon the feeding of rats have been found to be true of man.

So here, if one has patience to learn from the albino rat, is evidence based on experiments of the strictest scientific care, which bears out observations made upon growing children quoted above. They show that the quality and quantity of the food have a great influence on the size, sturdiness and precocity of young rats.

We can alter the quality of their food before weaning, by feeding the mother rat on different diets. If we give her a good diet, the quality and quantity of her milk are good ; if a poor diet, they are poor. A young rat is born helpless, blind and naked, and weighs about $\frac{1}{5}$ oz. at birth. He grows apace, obtains a coat of hair at about the tenth day, opens his eyes on the sixteenth day, begins to feed for himself on the eighteenth day, and may be weaned on the twenty-first day. Supposing his mother has been placed on a diet of bread, mineral salts, vitamins and water—this is a diet poor in the quantity and quality of its proteins, but in nothing else—then he may weigh $\frac{3}{4}$ oz. when weaned. He has nearly quadrupled his weight at birth. He is an active little fellow, fit to take up the burden of existence unaided. But if his mother has been placed on a good diet—*e.g.*, bread and milk, or bread and egg

yolk[1]—he may easily be *more than double the size* at the twenty-first day. Moreover, every function and attribute—sight, hearing, capacity to feed himself, and thickness of coat—will have developed earlier. He is more precocious as well as sturdier and larger.

The effect of poor or good food on his growth is almost instantaneous. If a mother rat is placed on a poor diet until the eighth day after the young rats are born, naturally the young grow at a slow rate for that time. If, on the eighth day, her diet is changed to a good one, an increase of rate of growth of the young is seen on the next day. If the experiment is planned the other way round, first a good diet and then a poor one, the young first grow at a great rate and then, after the diet is changed, at a slow speed. The results are most striking, as the accompanying graph will show (Fig. 1). These experiments form excellent proof that the quality of the food influences to a marked extent the growth of suckling rats, even though the food be handed on *viâ* the maternal organism. This is doubtless true for human beings.

Quality and Quantity.—These experiments on rats will be confirmed by anyone who has interested

[1] As an aside may we urge any nursing mother who has read the above *not* at once to place herself on a diet of bread and milk, or bread and egg-yolk ? These have proved good for the piebald pet rat, but experiments are wanting on human beings ! What " goodness " of food for human beings is will need patience to read and the rest of this book to explain.

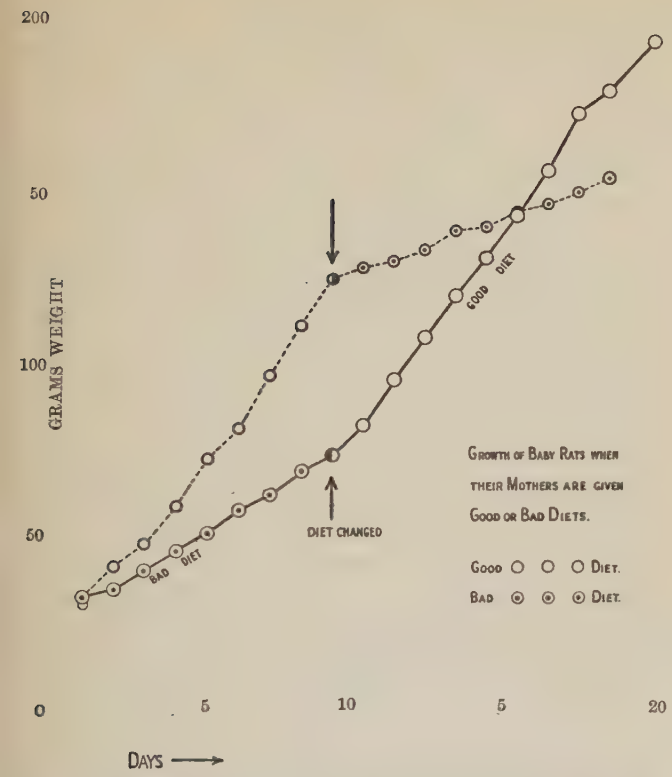


FIG. 1.—RATE OF GROWTH AND ITS RELATION TO THE MOTHER'S DIET.

This chart represents the growth of two litters of white rats when their mothers were on diets of bread and milk, and bread only, respectively. In eight days the first, whose mother had bread and milk, nearly quadrupled their weight, while the others, whose mother was on bread, only doubled theirs. On changing the diets round there was an instant response. Those whose mothers were now on bread and milk grew rapidly, while those whose mothers were now on bread only began to grow slowly.

himself in the artificial feeding of infants. Medical literature, particularly that of the United States, is full of such observations. As an example, the following account and growth curve of a baby are given: He weighed $8\frac{3}{4}$ lb. at birth, and was a perfectly normal child. After some initial trouble, due partly to vaccination and partly to a decreasing supply of natural milk, he grew at a normal steady rate till between the fifteenth and sixteenth week. By that time the mother's milk, which had been supplemented with a well-known brand of dried cow's milk to a total amount per day of 26 oz., had fallen to as little as 1 oz. only per day. As this amount was so small the child was weaned from his mother, and although the milk given was still at the rate of 26 oz. per day, growth ceased and, indeed, body weight fell during the next ten days. The first arrow on the graph marks the point of weaning. Instead of putting on 8 oz., which was to be expected, the weight fell by $3\frac{1}{4}$ oz. On the advice of a physician the reconstituted dried milk was increased to 31 oz. per day, with the result that the rate of growth increased at once, and in two and a half weeks the child had reached what he normally would have weighed [1] (Fig. 2).

We learn from this that the *quality* of food counts. Even the small amount of mother's milk (1 oz. per

[1] This experiment, which is good enough for the average person, would not satisfy the strict scientific observer, as there was no control experiment.

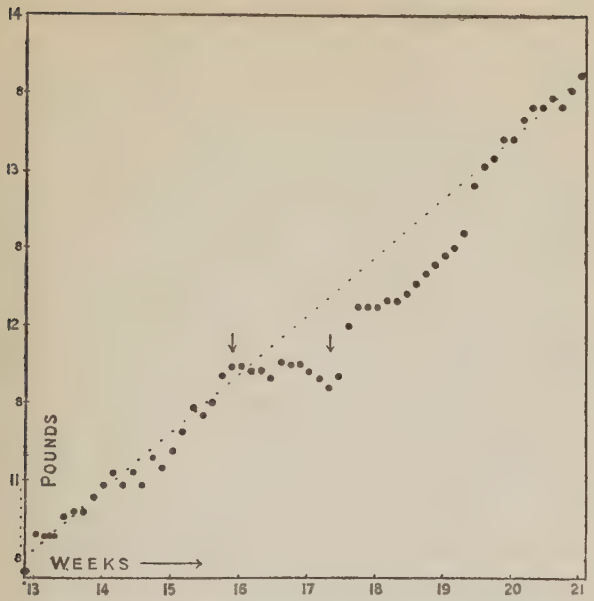


FIG. 2.—GROWTH AND QUALITY AND QUANTITY OF FOOD.

For the first three and a half weeks of this graph the baby was growing at a fairly constant rate. The round black dots represent the actual daily weight and the dotted line the average rate of growth. At the first arrow the child was deprived of the last ounce of mother's milk and was now on an entirely artificial diet. The quantity of food had not been altered (26 oz.), but there had been a slight alteration in quality (1 oz. reconstituted dried milk for 1 oz. mother's milk). Growth ceased for ten days. At the second arrow the quantity of food was increased to 31 oz. to make up for the change in quality. At once growth recommenced and in three weeks all deficit was wiped out. This observation shows that both quality and quantity of food are of importance in promoting growth.

day) yielded something which an equal quantity of cow's milk could not give. This lack of quality could, fortunately, be met by an increase of quantity

of cow's milk. It took, however, 6 oz. of cow's milk to equal that last ounce of human milk.

Any baby clinic can yield evidence of the value of quantity of food in influencing the rate of growth. For example, a baby which had been slowly losing weight on 25 oz. per day of reconstituted milk, gained at a great rate as soon as the amount was increased. For its size and weight the child had been receiving too little food, although it was getting the amount appropriate to its age.[1]

That the quantity and quality of the food profoundly influence the rate of growth of children after weaning has already been shown above (p. 23). But, as is usual, the completest proof comes from experiments upon animals. If young rats are fed on bread, vitamins, salts and water they grow at about the rate of $\frac{1}{25}$ oz. per day ; if on a good mixed diet, at a rate five times as great ! It is the poor quality of the proteins of bread (see Chapter III.) which is the reason for the slow rate of growth on that foodstuff. If we add a good protein (*e.g.*, caseinogen from milk) to the bread diet, we get a growth as good as that on the mixed diet. To some extent adding bread proteins (gluten) to the bread diet improves the rate of growth. But it never is

[1] It is unfortunately easy to overfeed babies, and dangerous. Especially is it easy and tempting to overfeed them with dried milk. This is no condemnation of these preparations, which have proved of the utmost value in artificial feeding. Any experiments should be made under the watchful care of a medical man.

as good as that on a mixed diet, or with bread and caseinogen. Clearly bread lacks both in the quantity and quality of its proteins, and this must largely account for the fact that slum children are undersized. They live too exclusively on bread. To be certain that the quality of food is sufficient, everyone, especially growing children, should take an all-round, well-chosen and mixed dietary.

The preceding paragraphs give, in some measure, what we may expect good food to do. There is much that it cannot do. It cannot, in later life, correct the results of poor feeding in childhood ;[1] it cannot add a cubit to the height of a person naturally short by heredity ; it is no cure-all. In saying this no doubt is thrown on the aphorism of Sir George Newman quoted at the head of this chapter. It should be emblazoned in gold on the walls of every kitchen, dining-room and restaurant in this country. But such extravagant statements are bandied about concerning the value of so-and-so's diet, or you-know-who's patent food, or of the effects of substituting brown bread for white in the ordinary man's pabulum that the fact must be emphasised that miracles are not wrought by food.

The function of any rational system of feeding is to promote growth and to preserve health, not to

[1] This is why medical men are so concentrating on the study of infant welfare, to the partial exclusion, no doubt, of adult welfare. This attribute of mind is entirely justifiable.

work miracles. A sound diet will not—nor will anything—turn you into a superman ; it may, if taken from childhood, enable you to be what Nature intended you to be. Nothing further should be demanded of it, or of any other *regimen* of life, and any promise to the contrary is a lie.[1]

In the next chapter an attempt will be made to discuss dispassionately the claims made for various systems of diet which the unkind and unscientific may term food fads. This chapter may be summed up as follows :

Food is the basis of growth and health. Consequently, if the food be poor, the growth, physique and health of the community will be poor. Naturally as growth is easily obvious to the naked eye, good food shows its most marked effects on children. Food lacking in one or other constituent may lead or predispose to disease ; good food will obviate it. Sometimes adjustment of the balance of foods is necessary, but for general purposes it is best to take an all-round, well-chosen, mixed diet rather than to rely on some special article of food, commercial preparation or drug.

[1] Lest this should leave an impression of pessimism concerning the value of food, may I again affirm that the health of the community is largely in the hands of those who cater for the community ? Good catering brings good health. Only by a scientific study of nutrition can the best results be obtained.

CHAPTER II

SOME FOOD FADS—FOR AND AGAINST

"Attempree dyete was all hir phisyk,
And exercyse, and hertes suffisaunce. . . .
No wyn ne drank she, neither whyt ne reed;
Hir bord was served most with whyt and blak,
Milk and broun bread, in which she fond no lak. . . ."

VEGETARIANISM is a cult as old as Adam, if not older. According to legend, its first convinced practiser was Adam's eldest son, who, after a turbulent youth culminating in fratricide, settled down, became a respected architect, and left numerous descendants skilled in arts and crafts. Time and again the cult has re-emerged into notice, and in this country a vigorous society was founded in 1849—a significant year—to promote vegetarian principles. The society is still flourishing. Elsewhere in Europe similar societies are found, with the result that in most cities of Europe, with a little research, vegetarian restaurants are to be found where a well-served and dainty meal may be had at smaller cost than its equivalent in an ordinary restaurant. Such resorts yield a pleasant avenue of escape from the monotony of the international menu.

Among the adherents of vegetarianism have been, and are, a number of prominent men. The names which most easily come to mind are those of Shelley, Bernard Shaw and Eustace Miles. Even professors of physiology have been numbered with the faithful.

Naturally the cult has attracted adherents from many other unusual cults. The djibbah-haunted coasts of Bohemia, the ingle-nooks of garden cities, the summer camps of Fabians hold more than their fair share of vegetarians. In fact, the vegetarian often lives in the society of cranks.

But this is no argument against vegetarianism. It must be considered on its merits.

The arguments in favour of vegetarianism are fourfold: æsthetic, sentimental, evolutional and pragmatic.

(i.) "Animal food is revolting." Who, walking through a meat market, has not often felt that? There you see hecatombs of slaughtered bulls. Their carcases are exposed to the city air with its dust and fogs and microbes, or to the coats of the passing populace. The meat is the camping ground of flies, which are hatched in ordure and repeatedly return thither, spreading filth and disease. When the meat has to be moved it is man-handled by an artisan Hercules in greasy overalls,[1] and as the carcases

[1] By a Public Health Regulation, which has come into force as this book is passing through the press, the wearing of clean overalls is prescribed for meat porters throughout this country.

are carried along their fat sides rub against his curly hair. Underneath the foot is blood, and throughout the air there permeates an odour, faint, but insistent and nauseating, of raw meat and incipient corruption. Romantic ? Perhaps when seen in the half light of dawn from the hospital gates across the way ; but in the crude noon glare, nauseating and repulsive.

(ii.) " Meat eating is cruel and inhuman." To sate his lust for flesh man snatches the calf from its mother and the lamb from his ewe ; tortures and mutilates the store cattle ; drags them miles by train and boat in cruel conditions of crowding ; and butchers them in each other's sight in dens reeking of blood and entrails. Even were the life of an animal destined for food that of the hero of a Sunday school novel and his death a euthanasia, the effects on those who direct them, and on the handlers of the carcase, are degrading.

(iii.) " Man by nature is a frugivorous [1] animal." According to the Darwinian hypothesis man is descended from monkeys ; monkeys live on fruit ; therefore man should live on fruit. So runs the syllogism of the vegetarian. Further man's teeth are not carnivorous in type, but herbivorous—or at any rate, frugivorous. He is departing from what Nature intended in killing and eating animals.

(iv.) " Vegetarianism works." Every now and then vegetarianism arranges an impressive display

[1] Fruit-eating.

of the prowess of its devotees. They win endurance tests, climb mountains, swim torrents, and lift weights against the rest of the world, and for their small numbers produce a disproportionate effect.

Sometimes this display impresses even the sceptical researcher in nutrition. For instance, a boarding school in the West of England, which has a vegetarian house, finds that that house, though numerically and otherwise on a par with the other houses, takes a larger percentage than its share of both the intellectual and athletic prizes of the school. The physique and health of this house are better than those of the other houses. All this can hardly be the result of "community spirit"—of the feeling that the boys of this house are a "chosen people" and must do deeds of valour and daring upon the Philistines. The interest of such experiments is so great that they should be further extended and investigated by the Medical Research Council of Great Britain.

Assuming the truth of these findings, is there any explanation of the good results of vegetarianism? Possibly the fact that there are less uric acid derivatives in vegetable than in meat foods, and there is therefore less difficulty in eliminating that source of trouble from the system, and that, as far as we know, vegetable foods *provoke* the production of no more uric acid in the body than meat foods. This may be one advantage.

Further, there is less risk of poisoning by decom-

posed vegetable than by decomposed animal food. The so-called " ptomaine poisoning " [1] is more often traceable to meat than to fruit or vegetables, though we must not forget that " botulism " [2] may result from tinned fruits, and that the poison curare, one of the subtlest in the world, is made from the decomposition of plant substances. On the whole, mild epidemics of " ptomaine " poisoning are less likely among vegetarians than among meat eaters.

A third advantage is that vegetable foods are a good source of the vitamins, and, lastly, the presence of much indigestible fibrous material in vegetables prevents the bugbear of stasis in the large intestine. Food does not remain long in that cesspool, there to decompose and poison the body through the channels of the blood. Vegetarians should not suffer from the effects of chronic constipation. There is evidence that vegetarian races—*e.g.*, the Punjabi and Himalayan villagers—do not suffer from cancer.

This, briefly, is the case for vegetarianism.

Before, however, we proceed to discuss the arguments enumerated above we must ask ourselves what vegetarianism is. There are three kinds : (i.) *fruitarianism*, a vegetarianism which admits of the eating of fruit only ; (ii.) *vegetalianism*, which admits of fruit and vegetables ; and (iii.) *normal vegetarianism* which adds milk, with its products,

[1] See p. 201.
[2] See p. 203.

butter and cheese, and eggs to the vegetalian diet. Presumably the last type of vegetarianism is based on humanitarian grounds—it is the taking of life to which it objects. Vegetalianism finds something objectionable in all animal things as food (though I suppose even strict vegetalians would be glad to put a baby to his mother's breast), and so holds milk, butter, cheese and eggs in abhorrence. And I imagine that the fruitarian considers vegetables as coarse and earthy and beneath his ethereal palate's contempt.

Fruitarianism.—For fruitarianism no sound argument can be found. There is the discredited argument from the descent of man: man is descended from the ape, the ape is frugivorous, therefore man should be frugivorous. The criticisms of this contention are: (i.) both man and the ape are supposed to be derived from a *common ancestor;* not man from the ape; (ii.) there is no evidence as to what our common ancestor ate, and if there was, that is no proof that we should eat it too; (iii.) man's teeth show some of the characteristics of carnivorous teeth.

Against fruitarianism most of the research of physiology cries out. To obtain the requisite energy, impossibly large amounts of fruit would have to be eaten. The protein of fruit is second-class protein, and is present in such small percentage that to gain the minimal amount of protein requisite per day, very

large quantities must be eaten.[1] Man simply has not the stomach capacity necessary for fruitarianism, nor the Crœsus' purse to pay for the necessary fruit.

Vegetalianism—The case against *vegetalianism* is much the same as against fruitarianism. Vegetables are too bulky. Either the proportion of protein is too low (*e.g.*, carrots, potatoes, turnips); or too indigestible (*e.g.*, dried peas and beans) to make them worth while. The proteins are not of first quality, and the best all-round diet cannot be chosen from plant products alone.[2]

Normal Vegetarianism.—But against the common interpretation of vegetarianism there is little or no scientific case. The terrible bulk of fruit and vegetables is overcome by using cheese. That food is concentrated enough! The poverty of the nature and quantity of vegetable proteins is enriched by the A1 quality of milk and egg proteins. Here at last is a diet which makes out as good a case as that of the mixed diet. Perhaps the utmost that may be said against it from the physiological standpoint is—stealing Dr. Johnson's comment on married life without quarrels—"Madam, how insipid." As will be seen later, insipidity is a physiological defect in a food.

This form of vegetarianism, which is not vege-

[1] *E.g.*, with apples nearly 4 lb. a day on the very lowest assumption, and more nearly 10 lb. on the usual assumption!

[2] See Chapters III. and IV.

tarianism at all, but a compromise, has no logical basis. Eggs and cheese are as crudely animal as a mutton chop, and are sometimes eaten in a much more revolting condition—*e.g.*, eggs in China and Stilton cheese in a West-End club. The wrongs done to animals in our lust for meat are but little worse than those done in our lust for milk and eggs or for wool and leather. Calves are snatched from their mother's side and fed unnaturally. The maternal piety of hens is thwarted and their philoprogenitiveness twisted to our selfish ends. It would be easy for the sentimentalists to shudder at the cold-blooded murder of incipient life every time the cook boils an egg.[1] The horrors of the milking shed and the milk can are little less than those of the shambles. Most of the arguments upon which vegetarians claim to found their food beliefs are nonsensical and illogical, but there are two which are sound: vegetarianism works and the physiologists can pick few holes in it.

Particularly unsound is the argument from Nature. To defend some particular fad or hobby it is unwise to invoke what happens in Nature. Nobody knows what happened when we lived in a state of Nature or what Nature intended us to do. This, however, does not prevent the recurrence of the idea from time to time that we should go back to Nature, lead a simple life and get rid of some of the complications of

[1] The Thibetan reviles us for ovocide.

modern existence. Hence "garden cities," hence hatless brigades, vegetarianism, fruitarianism and—one of the most startling—the refusal to use fire in preparing foods.

Probably the syllogism against cooking runs "no animal cooks food; man is an animal; therefore man should not cook." Some time ago there appeared on the market a number of loathsome concoctions called "unfired food." It was to be hoped that they and the cult had died a *natural* death, but, just recently, alas, a popular writer on cancer has resuscitated the argument. After the newspapers have exhausted the stunt of brown bread *versus* white, they will perhaps wage chivalrous war upon cooking. So it is wise at this point to inquire what a person means when he says a thing is not natural. Supposing someone were to say, with Ouida, that priceless best-seller of Victorian days, that man ought not to mix his flavours, his foods and his drinks because it is unnatural and no animal does it. How shall we defend mustard with beef, red currant jelly with mutton, and bread sauce, with its seventeen ingredients, with chicken? Can we maintain that a meal which contains salt hors d'œuvres and sweets is natural?

The answer is that the user of the argument neither stops to think what the word "natural" means, either to him or anyone else, nor to see whither the argument would lead him. If he

answers that "natural" means anything that happens in Nature, then it may be retorted that man is a part of Nature and so that anything he does is natural. Thus aeroplanes, top hats, tube railways and high-heeled shoes are natural, and cooking has its defence. If he answers that "natural" means anything that happens in Nature exclusive of man, he gives his case hopelessly away, for he admits that man is unnatural. If this logical dilemma does not impale him—you cannot hope to convince him—there is nothing left but to advise him to live in a cave in some uncivilised part of the earth and wrest a living from Nature by the sweat of his *own* brow.[1]

Are clothes, houses, gardens, vegetables, novels, speech and books on food found in a "state of Nature"? Man, of course, has transcended the "Nature" of the wild animals and has doubtless both lost and gained in the process. Cooking is a gain from the nutritional point of view,[2] in that it improves the flavour and digestibility of food, and such a gain probably has resulted in some loss in other ways. It may be that hot food causes cancer of the stomach. The obvious remedy is not to give up cooking food, but to take it not quite so hot.

On the whole it is not wise to argue with the upholders of unfired food, or of some similar crank,

[1] The writer has often found that the crank lives on dividends on money earned by someone else.

[2] See Chapter VII.

for it is commonly true that when they denounce a thing as unnatural they really mean that they have some fanatical dislike of it for which they can give no logical reason. If there is anything natural about man it is his will to conquer Nature.

Fletcherism.—One of the saner food fads is "Fletcherism." This consists in chewing one's food so many times that before it is swallowed it has lost all flavour.[1] The originator and protagonist of the cult maintained that he needed much less food than the normal man because he chewed his food so thoroughly instead of bolting it in a semi-masticated state. Doubtless he pointed to the chewers of history, of whom Gladstone was the most famous. He masticated every mouthful thirty-two times and maintained a physique which enabled him to lead an extremely active and wearing public life and live to the advanced age of eighty-eight. Bolted food is certainly a cause of indigestion, and if such indigestion is serious, undoubtedly less is obtained from the food. As will be shown later,[2] there is a chain of digestive secretions in the alimentary tract, each secretion depending on the preceding link in the chain. To start the chain of reflex secretions a thorough chewing of the food, if not essential, is advisable. Especially is this true of starchy and uncooked vegetable foods (salads, etc.). Fletcherism

[1] For the importance of flavour in food, see Chapter VII.

[2] See Chapter VII.

obtains, then, a mild support from the physiologists and a more strong support from dentists, who believe in the use of crisp food, such as toast, apples and lettuce for their power of cleaning the teeth and in the need of thorough mastication of all foods.

The devotees of Fletcherism, however, carried their claims to extraordinary lengths. Like most people conscious of possessing some of the world's stock of truth, they exalted it above all others. When accurate experiments were made to test its chief claim—that very thorough chewing enabled the experimenters to obtain much more nutriment from their food than the average man—and the experiments threw very grave doubt on this claim, they impudently impugned the doctrine of the conservation of energy. This doctrine is a fundamental doctrine of science, and if it be false all science is false. Consequently, no scientist can accept their claims. Moreover, the protagonist refused to include in his dietary tables the bag of chocolates from which he refreshed himself from time to time throughout the day! So obsessed with the value of chewing was Fletcher, and the power of the body to obtain protein, etc., from highly triturated [1] foods, that he spurned foods which contain much roughage. It is certainly true that the body absorbs more protein from a smooth food, such as white bread, than from a coarse food, such as brown bread, which

[1] In a state of fine division.

contains roughage. So Fletcher refused to take fibrous foods, thus coming into conflict with physiologists and dentists, who maintain the value of such foods as detergents to the bowel and the teeth. He carried this to such lengths that he doubtless shortened his own life, allowing himself to be poisoned by materials manufactured by microbes in his large intestine.[1] Some roughage is necessary to everyone past the age of infancy, even if he waste a little of the nitrogenous substances of food in the process of digestion. Carried to extremes, Fletcherism is illogical, unscientific and dangerous, though there is a modicum of truth in the cult.

The Question of Drink.—Some time ago there were heard two rival slogans: "No drinks at meals" and "No drinks between meals." Probably the slogans had more reference to the type of drink than to fluid in general. None the less, there are to be found people who maintain that to drink at meals is unhygienic. This view is based partly on the alleged fact that no animal does it and the undoubted fact that one type of dyspepsia is benefited by taking little or no fluid during a meal.

Certainly the "washing down" of food by copious drinks during the meal has something unphysiological in it and is condemned by dentists. The saliva has some work to do, both digestive and

[1] See p. 76, "Roughage."

detergent. According to the dentist, saliva is secreted to keep the teeth clean, and to the physiologist, to start the digestion of cooked starch and to originate a chain of digestive reflexes thereby. Possibly over-dilution of the food by drink would slow the activity of the digestive ferment of the saliva, and starch, therefore, must wait about undigested in the stomach, giving any microbes swallowed in the food their chance to produce trouble. From first principles we should expect salivation to suffer from disuse and various digestive troubles to ensue on the "washing down" of food. Whether there is any scientific evidence of such I do not know. The practice looks horrible and that suffices for the ordinary man.

In abnormal states of the body there is doubtless evidence that large draughts of fluid at a meal are not advisable. The dilution of the gastric juices will decrease their rate of action and will result in the food's remaining longer in the stomach than otherwise, firstly because there is a large volume of material to bring to the point of acidity at which it is allowed to leave the stomach, and secondly because the stomach muscles work more effectively in passing along a pasty mass than they do on a liquid. If the stomach be at all sluggish, then certainly at meals fluid in large quantities is inimical to good digestion. The food will stay longer than normal in the stomach, and not being rapidly

acidified bacterial decomposition is likely to take place.

On the other hand, if the stomach be over-active, both in secretion and motility, large drinks at meals are clearly advisable.

Why should, however, the average man worry himself with what is likely to be prescribed by the physician for an abnormal state of the body? Even if he suffers, or thinks that he suffers, from indigestion, he cannot tell whether it comes from too great or too little activity of the stomach. The physician is the only man who can tell him what is the matter. Until he falls into his hands the right line of action for the normal man as regards drinks at or between meals is "FAY CE QUE VOULDRAS" or "Do what thou wilt."

Finally, there is the problem of alcohol: Does it promote or retard digestion? Is it a food or a poison? Does it make for good or evil? Unfortunately the answers are often ambiguous, or the moral problem is found to clash with the scientific problem.

Alcohol and Digestion.—There are occasions [1] when it is conceivable that a little alcohol will promote digestion, but no doubt alcohol in excess delays digestion—witness the state of a person who has indulged too heavily at a feast. Alcohol has so

[1] See pp. 183 *et seq.*

upset his alimentary tract that it refuses the lightest of food.

Alcohol as a Food.—Accurate experiment has shown that two ounces of alcohol taken in small doses during the day can be burnt by the body with but a 5 per cent. waste. Such an amount is found in the average bottle of claret, which, however, the moderate drinker would not be content to take in such homœopathic doses. Taken in this way, not only can the alcohol be used to provide the body with energy, but it can take the place of fat or carbohydrate. Alcohol must, therefore, be reckoned a food, though, perhaps, a dangerous food.

Alcohol as a Poison.—There can be no doubt that alcohol is a poison. In the concentration at which it is found in wine it depresses the activity of naked cells, and at a slightly greater concentration it kills them. Absorbed into the blood stream it is distributed to all parts of the body and influences the activities of the cells of the body. Of all the tissues, probably the heart is the only one which alcohol stimulates. On the cells of the nervous system it has a depressant action—even the apparent stimulating action has been explained paradoxically by its depressant action. A man who has taken a little alcohol often appears brighter,[1] but this is because his control of his actions by his higher centres has

[1] See p. 184.

been removed or depressed. On the whole, the balance on the scientific side of the argument is against the use of alcohol, and he who takes it does so on other than physiological grounds. Though physiologists as a group are not teetotallers by any means, many have spoken against the use of alcohol. One of the foremost workers on the science of nutrition writes : " In the light of the social evils which accompany the excessive use of alcohol as a beverage, there is no doubt that its total prohibition—if this were possible—would make for the public weal, and improve the physical and moral condition of mankind."[1] Many physiologists have told the writer that they abstain from alcohol on the eve of an important experiment. The possible lines of defence of the use of alcohol are given in Chapter VII., and it must suffice for the present to say that, while for the moderate drinker total abstinence may increase his pocket-money, and possibly improve his temper in the morning, it will no more than any other of the cults described above produce a miraculous improvement in health. Care in manifold directions is the only way to promote and preserve health. Certainly nutrition is one of the more important, but fanatical attention to one small point in nutrition will not make up for neglect of all the rest.

Summary.—Consideration of a number of food cults

[1] Graham Lusk, " The Science of Nutrition," 3rd edition, p. 358.

and fads shows that there is little to be said for any of them. Often their claims are extravagant and fantastic. Most of them are based on sentimental, and not on scientific grounds. A vegetarianism which permits the use of milk, butter, cheese and eggs comes nearest to the ideal, viz., an all-round mixed diet, and fulfils most of the desiderata of the physiologist. What these are the next chapter will discuss.

CHAPTER III

FOOD: ITS NATURE AND FUNCTIONS

"Then they began to discuss merrily together; speaking first of the virtue, propriety, efficacy and nature of all that was served in at the table."

WHAT *is* Food? Such a question must often have sprung to the lips of the pert and inquiring child when the domineering parent has wished him to swallow something he dislikes on the plea that it is "good food." Such a question is difficult to answer. The term "food" must include things to drink, such as water, milk and tea, solids, such as salt, even indigestible materials, such as vegetable fibres, and exclude betel nut, chewing gum and tobacco. An attempt at a definition of a food is the following: "A substance of pleasant or unobjectionable flavour capable of building up or repairing body tissue, or of being used to provide or regulate the supply of bodily energy."

Perhaps the position of the word "flavour" in this definition will startle some people, for it will rule out for them things they dislike from the category of foods. Thus some persons intensely dislike tomatoes, or parsnips, or eels. For them, by defini-

tion, tomatoes, parsnips and eels are not food. As will be seen in Chapter VII., there is much to be said for this point of view. Distasteful comestibles are not useful as foods to those to whom they are distasteful. If, however, the logic of this argument seems weak, the following emendation of the definition will meet the case: "A food is a substance, of pleasant or unobjectionable flavour to the common run of people, capable of building up or repairing body tissue, or of being used to provide or regulate the supply of bodily energy."

The Fivefold Function of Food.—We have already said that the whole of the material for growth comes from the food we eat; *one function of food is that of providing such material to be utilised for growth by the growing child.* Further, tissues of the body are continually being worn out as the result of the work they do. Even when we are physically resting, parts of us are hard at work, *e.g.*, the heart. All work entails some amount of destruction of the tissues, and the worn-out parts have to be replaced. Hair, nails and the skin are continually growing and as continually being cut, worn or sloughed off. Material is needed for this. Tissue damaged by abrasion or by wounding has to be replaced. Such wear and tear is made good from foodstuffs. There must be a fund to meet depreciation, and this *depreciation is made good by food, and food alone.* Still more, the

body needs energy. All through life it is dissipating energy. Stairs are climbed, cranks are turned, 'buses and trains are caught, and gardens are dug. All this entails work, and *this work* (*or energy*) *comes from the slow utilisation and combustion of food in the cells of the body*. In addition, as the body maintains a temperature considerably above that of the surrounding air—except, of course, in tropical climates—it is losing heat all the time to environment. We check this loss by clothing, by living in houses, or by warming our surroundings. None the less, heat is lost, and must be re-formed by burning food. Finally, this output of bodily energy has to be controlled and directed. To this end sundry catalysts[1] (see this chapter: "Vitamins") are needed. *Some of these can be supplied from the food only*.

No Food is Perfect.—Food, then, has a fivefold function: to promote growth and repair, to serve as a source of energy or heat, and to regulate the energy supply. No one food can claim to be able to do all these things. *Therefore there is no such thing as a perfect food*. Nor can we rate any one food so much more highly than another. All may have their uses. The perfect food can only be obtained by mixing the various imperfect foods so that the

[1] These are substances, dear to the hearts of industrial chemists, which by their mere presence in small amounts quicken a process till it takes place in a reasonable time and not eternity.

defects of each are made good by the others—hence the need for a good all-round mixed diet.

The Essentials of a Diet.—A diet to be considered good must contain the following substances:[1] (i.) proteins, (ii.) fats, (iii.) carbohydrates, (iv.) roughage, (v.) salts, (vi.) vitamins, (vii.) extractives (for flavour), and (viii.) water. A consideration of even one of the acknowledged best foods will show how imperfect a good food may be. Thus milk, though it contains proteins, fats, carbohydrates, salts (though poor in iron), and vitamins, contains no roughage, and so is liable to produce constipation. Meat is deficient in carbohydrate and roughage; vegetables are deficient in protein and fat; bread—the staff of life (!)—is deficient in good protein, fat, iron and calcium, vitamins A and C, and, if it be white bread, in roughage. It is clear from this that no one foodstuff should exclude the others from the daily menu. A mixed diet—"fine confused feeding"—is essential. As we shall see later, the least basis upon which we can build up a rational regimen is meat[2] (including fish), eggs, milk, bread, butter, root and green vegetables, salad and fruit. To demonstrate this will necessitate some pages of explanation of the terms used a few lines above.

[1] For definitions, see above (Introduction), and the ensuing paragraphs.

[2] Perhaps meat may be omitted if cheese takes its place.

Proximal Principles of Food.—(i.) PROTEINS.—These are substances so essential to life that attention to them has in the past excluded attention to the other constituents of diet. The goodness of a food used to be measured by its content of protein to the exclusion of other things. We now know that this attitude of mind—not, however, yet quite in eclipse—was mistaken. None the less, proteins are of vital importance. No animal can live without them. They enter into the framework of every part of the body—every cell and every tissue—and must be supplied in the food to enable growth and repair to take place. Sometimes we meet them in nearly pure form in foodstuffs, but usually they are mingled with other constituents. Thus the white of egg is an almost pure protein with admixture of little else. It is such a characteristic protein that the Germans have adopted the word *Eiweiss* (= egg white) where we, and most other nations, use the word "protein." The lean of meat, too, has so large a percentage of protein that it is not far wrong to take one's conception of what protein is from meat. Other sources of protein are milk (3 per cent. of whole milk, or 30 per cent. of the solids); cheese, 30 per cent. (*circa*) in hard cheeses and 20 per cent. (*circa*) in soft; pulses, *i.e.*, peas, beans, lentils, 20 to 30 per cent. Practically no common foodstuff, with the exception of sugar, is devoid of protein.

The Multiplicity of Proteins.—Now, there is no one substance "protein," but thousands. Every plant and every animal has its own peculiar type of protein of its own specific stamp. Further, every tissue, in the same way, has its own type. The proteins of a liver cell differ from those of the kidney, and these from those of the muscles or of the lens of the eye. The differentiation goes even further: each part of a cell may easily have its own specific protein. There may be millions of different proteins.

The Reason for their Differences.—That proteins behave differently is well known to the cook. Egg-white when boiled or baked becomes white and opaque and insoluble. It coagulates. So does the protein of meat. But not so the chief protein of milk. It remains in solution, but will coagulate (clot) on the addition of rennet to it to form junket. Most proteins are insoluble in 70 per cent. alcohol, but some of the cereal proteins are readily soluble. In fact, there is infinite variety in their reactions.

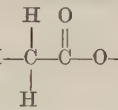
The reason for the difference lies in their architecture. Proteins are highly complex chemical substances. The weight or mass of the smallest particles (molecules) is enormous when compared with water or other simple substances. Thus, at the lowest computation, the proteins are nearly a thousand times as complex as water. Perhaps the best idea is given by comparing a protein with a cathedral

and an ordinary simple chemical substance like salt, water, or carbon dioxide, with a hut.

Protein Architecture.—But just as a cathedral is built of simple elementary substances so is a protein. Its fundamental building stones are few in number and comparatively simple. Into St. Paul's Cathedral stone, brick, iron, wood and mortar are combined; into a protein some twenty fundamental building stones, known as amino acids.[1] The names of six

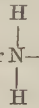
[1] The amino acids are organic acids, such as acetic acid, found in vinegar, into which an amino group derived from ammonia has been introduced. The chemist writes, in his shorthand, acetic acid thus :

$CH_3.COOH$, or, at greater length,

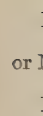


This means that two atoms of carbon (C) are joined together, and that to one of them three hydrogen atoms (H) are attached, while to the other there is attached two oxygen atoms, and that one of these is linked with a further hydrogen.

Ammonia he writes as NH_3, or

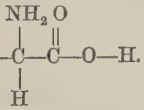


, and the amino group as NH_2,



.

If we put an amino group in the place of one of the hydrogen atoms attached to the first carbon atom we get $CH_2NH_2.COOH$ (amino-acetic acid) or



This is the simplest amino acid, but the ones found in proteins are

of them—the most important for life—are here given. They are lysine, arginine (or its near relative, histidine), phenylalanine, tyrosine, tryptophane, and cystine.

Now, one protein differs from another merely in the number, nature and arrangement of the building stones. It may contain in its structure all the twenty amino acids, or only three. It may specialise in one type of amino acid and have more of it than of any other—some may contain much glutamic acid, others much tryptophane. It may omit one or two of the amino acids—gelatin lacks tryptophane, tyrosine and cystine ; zein, from Indian corn, lacks tryptophane and has very little lysine. Finally, the arrangement of the amino acids within the protein molecule may vary. In the daisy chain, or whatever the linkage between the amino acids in the protein be, the amino acids may have different partners. Thus the caseinogen of sheep's milk apparently differs from that of cow's milk merely in that the two end partners at one end of the complex have changed places ! There is thus possibility of almost infinite variety among the proteins, and so far as research has gone there is every reason to believe that the theoretical possibilities are facts.

The simile of architecture used above holds good

built upon the same lines, and are not too fearsome in their structure and formulæ. For a further discussion of them, the student is referred to such a book as " Fundamentals of Biochemistry," by T. R. Parsons (Heffer & Sons, Cambridge).

and illustrates the multiplicity of proteins. Perhaps not more than twenty types of building material enter into the structure of St. Paul's Cathedral, Westminster Abbey, and the Roman Catholic Cathedral at Westminster; and probably all the twenty are used in each, but in different proportions. Westminster Abbey apparently contains much stone; St. Paul's, stone with some brick; the Roman Catholic Cathedral brick with some stone. These are first-class buildings, but they differ from a slum dwelling in having more of the different types of building material in their structure. And they differ from each other in the emphasis they lay on any one building material; and, again, in the way that building material is put together. So with proteins. There are slum proteins and cathedral proteins, and they differ for similar reasons: the number, nature and arrangement of the types of building materials used in their structure.

The Amino Acids the Indispensable Units.—From these considerations we could hazard a guess that in building the architecture of its own proteins the body needs not proteins, but their contained amino acids. A piece of plant or animal protein cannot be incorporated whole into the body of an animal. In fact, any such attempt is dangerous. Were you to squirt a little egg protein into your blood stream the result would be unpleasant, if not disastrous. In the War

of the Worlds the Martians injected the blood of terrestrial animals into their own blood stream; but in ordinary mundane affairs that is impossible. In fact, it is dangerous to inject human blood into the veins of even another human being unless it has previously been found to be compatible. Foreign proteins act as poison if introduced into the blood stream. It is otherwise with the amino acids. These are what are wanted, not the proteins as such. Animals can be kept in health on proteins which have been artificially digested till nothing but amino acids and simple peptides [1] are present. And the whole meaning of digestion of proteins is this: that the body must pull to pieces the architecture of plant and animal proteins, before it can, from the building stones it thus obtains, construct its own proteins in its own style of architecture. It is as though, before building St. Paul's, Sir Christopher Wren had to pull to pieces cottages, houses, business buildings, and banks, and from the materials thus obtained erect his cathedral. Each body is the architect of its own proteins, and gains the material for its building from the disruptions of animal and plant proteins.

Origin of Amino Acids in Nature.—Not from any other source can the body obtain the amino acids it wants. It cannot manufacture out of any raw material, such as other amino acids, lysine, arginine, histidine,

[1] Linkages of but a few amino acids.

phenylalanine, tryptophane, tyrosine and cystine. Plants, however, can. They manufacture these amino acids from such simple things as carbon dioxide, water and ammonia. Animals, such as oxen, obtain their proteins from plants, while we and other omnivorous and carnivorous animals obtain ours either in part or wholly from animals. Our capacity for existence thus depends on the power of plant life to manufacture from simple materials the all-important amino acids.

Varying Values of Proteins.—The next point which arises is that since proteins differ in the nature and relative number of the amino acids which go to form them, they cannot be equally valuable to the body. One protein (*e.g.*, zein) is deficient in lysine and tryptophane, another (*e.g.*, gelatin) in tyrosine and tryptophane. As it can be shown that there are definite minimal requirements of the body per day of lysine, tryptophane and tyrosine, it is obvious that gelatin and zein are not so valuable to the body as other proteins which contain adequate amounts of those amino acids. Further, if 1 oz. of a given protein contains twice the minimal ration of lysine and another just the minimum per ounce only, it is clear that the first protein is more valuable than the second, at any rate, as far as concerns lysine.

From such considerations, it is clear that the proteins in our food should furnish all the amino

acids necessary to construct human proteins and in the relative proportions in which they are found in human proteins. No one protein is likely to fulfil these requirements except human protein. So that, if we wish to restrict ourselves to one source of protein, we ought to become cannibals! Otherwise we must mix the proteins in our diet. Any restriction of any kind (*i.e.*, to leaf or root or cereal proteins) may endanger health, owing to absence of some essential amino acid, or may entail gross overwork on the part of the digestive organs, which will have to tear to pieces so much material to find the correct amounts of the indispensable amino acids. The simile from architecture should make this clear. If the architect of a brick cathedral had to find his materials by pulling to pieces other buildings, he would have to "work over" many more stone houses before he found the necessary bricks than if he utilised brick houses, and there would be much more material wasted. Proteins of diet should, when disintegrated into their component amino acids, show the same range and relative proportions of the amino acids as human proteins. A mixed diet is the only easy way of ensuring this.

The Grading of Proteins.—Proteins can be graded according to their value in diet. The term usually employed is "biological value"—a perhaps unfortunate term when used to indicate value in human

diet. Theoretically, a protein would have a different biological value for every animal that ate it. The proteins of Indian corn may easily have different values for the domestic fowl, the pig and the human being. However, the term " biological value " has come to stay and the idea is capable of mathematical definition. It is the ratio between the body protein spared or repaired and the food protein necessary to spare it, multiplied by 100. An example will make this clear. Suppose the minimal loss due to wear and tear of protein in the body is 4 grams per day (expressed as nitrogen), and exactly to replace that wear and tear 5 grams of nitrogen in the food protein is required. Then the biological value of that protein is $100 \times \frac{4}{5}$, or 80, or we say that its value is 80 per cent. of that of body protein.

Actual Results.—The idea is simple; but the carrying out of the experiment is very tedious and difficult. It is almost certain that the original experiments made in this work were inaccurate and that the figures given (and largely quoted in text-books) will not bear close scrutiny. But one thing undoubtedly has come out of the work. Proteins do have very different values. It is fair to state that, as a class, animal proteins have the highest biological value. The ones tested were those of beef, milk and fish. In the second class are put the proteins of potato,

rice, cauliflower and spinach, while in the third class are found those of wheat and maize. A recent elaborate and accurate investigation puts the biological value of gelatin at zero, of wheat proteins at 39, and of milk proteins at (doubtfully) 51.

So far as research has gone, there is strong evidence that the proteins, when taken individually, have different biological values. The moral to be drawn is: *proteins of high biological value are to be esteemed, and every diet should contain some of the highest biological value.* But this is not to be pressed too far. Proteins of low biological value need not necessarily be excluded from the diet, for a protein which, by itself, has a low biological value may, in conjunction with another protein, have a high value. The biological value of gelatin is zero, that of wheat protein 39, but the combination of gelatin and wheat *might* have a biological value of 50. We already know that addition of gelatin to bread greatly increases the growth-promoting power of bread. Owing to the power of proteins to supplement each other's lack of definite amino acids, it is conceivable (though not likely), that two proteins each of zero biological value, together might have a biological value of 100 !

While it is essential, in the present state of our knowledge, to include some first-class proteins in the dietary, it is not essential to exclude proteins of poor biological value. In the presence of first-class proteins, third-class proteins may prove to have a

use greater than their class would suggest. There is good ground for utilising wheat and maize proteins as adjuncts to our sources of good proteins, and so the best advice to give at present is that the *diet should be as varied and mixed as the purse will allow, and that first-class proteins should on no account be omitted.*

(ii.) FATS.—The second essential of a good diet is fat. Fats are substances not easily definable. We most of us have a fairly good idea of what a fat is, but this idea may include sundry substances (vaseline, lanolin) which are chemically not fats, and exclude olive oil and other oils which are used as foodstuffs and belong to the chemical class of fats. For convenience sake—chemically it is indefensible—under the term "fat" we shall include all substances which might be dissolved from foodstuffs by light petrol. These include the fats of meat (*e.g.*, mutton, beef, pork, goose, duck, fowl, etc.); of fish (*e.g.*, herring, mackerel and salmon, etc.); of milk (*e.g.*, butter, cream and cheese); of plants (*e.g.*, olive, cotton seed, and maize oils). Also are included the lipoids (fat-like bodies), such as lecithin from the marrow or nervous system, and cholesterol (from plants and blood, etc.).

True fats (*e.g.*, mutton fat and olive oil) form about 90 per cent. of the fat-like substances we eat. They are—as is known to most modern schoolboys,

but apparently not to civil servants during the late War—composed of glycerine united with fatty acids. In fact, they are the sole source of glycerine, which forms about 5 per cent. of the weight of fat. Fatty acids are not known to the average man in the street except as their sodium compounds (soaps), or as butyric acid, which helps to flavour cheese.

Distribution of Fat.—No analysis fails to find some fat in foodstuffs—sugar is an exception—though the amount may vary enormously. Thus the potato—excluding skin—may contain as little as 0·01 per cent. No ordinary fruit or vegetable contains much, parsley holding the record with 0·7 per cent. Cereals contain more: rice 0·3 to oats 8·4. The "white" fish are deficient in fat (cod 0·1) while others, such as herrings, have as much as 10·0. Meat, butter, cheese and nuts are the foods in which there is a goodly percentage of fat.

Results of a Fatless Diet.—Every adult, of choice, includes some fat in the daily food; but children are apt to reject it in its ordinary form, and there are a few unfortunate children to whom it is poison. Whether fat is absolutely essential is a moot point. It is clearly not necessary for all animals. The pasture-fed sheep gets but very little. Experimentally, fat may be removed entirely from the food of the albino rat, and as long as a sufficiency of vitamins is given the animal is not a penny the worse.

With man it is otherwise. In the laboratory, on a small scale, and in central Europe during the War on a large scale, the experiment has been made. Fat has been wholly or partially removed from a diet. After a short time an intolerable craving for fat arose. In Germany, owing to the blockade—instituted to prevent the Germans obtaining the raw material, glycerine, for explosives—the fat ration was cut down to half or less than the normal. So intense was the craving for fat that many substances having the texture of fat, but having no food value, were eaten. The wife of the American Ambassador records that her lady's maid stole and ate, spread on bread like butter, her mistress' face-cream !

Advantages of Fat.—Fat has the following physiological value. First of all it yields much warmth when burnt by the body. One portion by weight of it will yield more than twice as much heat when burnt by the cells of the body as will either protein, starch or sugar. It is, therefore, convenient in that it is not so bulky as the other foods. (Compare a cheap grade fuel, *e.g.*, peat and soft coal, with anthracite.) Second, it delays the rate of digestion in the stomach and is but slowly oxidised in the body. This results in a feeling of well-being, of satisfaction and of lasting power in the food eaten. A Continental breakfast of rolls, honey, and coffee leaves the globe-trotting Briton uncomfortably dis-

satisfied midway through the morning. Breakfast bacon makes him feel all glorious within. Finally, and perhaps this is the most important of all, fats are usually the vehicles for one of the vitamins (see below). Fats—animal fats mainly—are not the only vehicles for vitamin A, but the majority of us find in fat the main source of that vitamin. When we miss fats from our food we do not perhaps miss their warming power, nor the comfortable sensations of an occupied digestive tract, but the vitamin A which so many of them contain.

Drawbacks of Fat.—But fat has its drawbacks. To consume large quantities needs training, *e.g.*, in cold climates or in the treatment of diabetes. It is a difficult substance to digest and burn in the body. Even if the digestion is efficient and fat is readily absorbed into the blood stream it has to undergo a process of being burnt in which a definite amount of sugar is needed. If we try to live on protein and fat only, "biliousness" results. The body cannot completely burn the fat, and bodies such as aceto-acetic acid and acetone appear in the blood, and one or other of these bodies produces a sensation of malaise and nausea. Headache and sickness result, with an utter lassitude and distaste for food. Starch (as bread) or sugar will soon restore the balance and provide a means of burning the fat. The capacity for burning fats varies from person to person and

each one finds by experiment his limits of toleration. They are clearly higher for the Eskimo than for the Englishman, though the latter may train his body to consume much more than the average allowance.

Fat, then, is a most useful form of food, but has some drawbacks. It must be balanced with starch and sugar. And it is costly—or rather the common sources of animal fat are costly. No particular advice is necessary as regards its use, except that animal fats are to be preferred to vegetable fats, on account of the vitamin A in animal fat, and that fat should be taken in a good all-round dietary. Inclination and habit are to be consulted. A heavy admixture of fat and proteins is to be avoided.

(iii.) Carbohydrates.—These are substances built up of carbon, hydrogen and oxygen, the latter being in the same proportions as in water. Hence the name, which is a beautiful hybrid of French (*charbon*) and Greek (*ὑδωρ*, water). If you take water from sugar (a typical carbohydrate) you have nothing but carbon left.

The carbohydrates of interest and importance to us in food are starch and sugar, mainly, together with the indigestible cellulose of vegetables, which acts as "roughage." They are widely distributed in foodstuffs and form about two-thirds by weight of what the ordinary man eats.

The Starches.—The starches are storage products of

plants, and so are found in tubers, such as the potato (18 per cent.) and artichoke (14·5 per cent.); in roots, *e.g.*, carrots (10 per cent.); in seeds, such as the pulses (*circa* 50 per cent.), and in grains, such as wheat and oats (*circa* 70 per cent.). Like proteins they are very complex, but, unlike proteins, they do not contain many building stones. Possibly the whole-starch molecule, weighing as much as the largest protein molecule, contains but one type of building stone, viz., malt sugar. Though starch from different sources looks different under the microscope, probably it does not differ chemically. There is, at any rate, little reason to believe that there is any difference in the digestibility or capacity for absorption of the digestive products of wheat starch or potato starch. Each on digestion yields as the final product, grape sugar, which is easily absorbed by the intestine and easily utilised. The apparent difference is explained by the difference in the plant cells which manufactured the starch.

Over the tiny starch grains is a thin cellulose envelope ,which, before the starch goes into solution, must be burst. This happens when the starch is cooked, and as the greater part of the starchy food which man eats has been cooked, the starch is easily available and open to the action of ferments. Nevertheless, he may take uncooked starch, or starch which has been subjected to heat too short a time for the grains to have burst. It is said that much of

the starch of biscuits has not been so exploded ; but this does not result in the starch's being of no use to the body. True, it is not digested in the mouth or the near end of the stomach ; it has to wait two or three hours till it is passed on to the small intestine, there to meet the digestive juice secreted by the pancreas. Presumably most of the starch eaten by animals has to wait till it reaches the small intestine before it is digested.

Starches in process of digestion, or as the result of heat, turn partially into substances known as dextrins. Of these there are very many, ranging from ones almost as complex as starch to ones almost as simple as malt sugar. They do not occur naturally, but are interesting to us as appearing in the crust of bread, or anything that is baked or fried "to a delicate golden brown." Dextrins are highly digestible, a fact which should be remembered by those who utilise dextrin photographic pastes. One lick to the brush will ruin a whole bottle, for saliva will digest the paste to a thin watery fluid with no "stick" in it !

The Sugars.—The sugars are much simpler than the starches. The two best known to most people are cane sugar—the ordinary table sugar, made from sugar cane or the sugar beet—and grape sugar, found in many fruits, and at times obvious in and on dried fruit, such as muscatels. Honey, too, has a

very high percentage of grape sugar, or glucose, as it is more often called. But other sugars occur in foodstuffs. In milk there is a very important sugar known as milk sugar. It, when solid, is white and almost tasteless (wherein probably lies its value). Six to seven per cent. of human milk consists of this sugar—approximately twice as much as the other solids put together. Much milk sugar goes to waste in every cheese factory and is lost to human and animal consumption, though attempts are now being made to recover it and market it. It is finding a use, as an addition to dried cow's milk for the artificial feeding of babies and as a protection against the troubles of nausea and sickness in the early months of pregnancy.

Malt sugar is another sugar of some importance. It is produced from malt—*i.e.*, sprouted barley—and finds its use as a basis of many patent foods, *e.g.*, malt extract. Cane sugar, milk sugar and malt sugar belong to the class known as disaccharides. They have a molecule with twice the number of carbon atoms which the simpler monosaccharides, such as grape sugar, possess. The starches are built from many molecules of the simpler sugars and are therefore called polysaccharides. Only one carbohydrate of any importance as food is found in animal tissues, and that is glycogen, a polysaccharide somewhat resembling starch. It is found in muscle, particularly in horse meat, to which it gives a slightly sweet

flavour. In much larger amounts it is found in the liver of most animals. It is also present in oysters and mussels, and in crayfish, lobsters, and crabs. Except, however, in the liver, it is present in but low proportions.

The Value of Carbohydrates.—Carbohydrates as a whole are of great importance in diets. They form, as already said, about two-thirds of the food we eat. They are cheap, easily digested, and absorbed by the alimentary tract; are readily utilised by the tissues of the body; they help to combust the fats, and, finally are, according to modern theories, the source of all muscle energy. Even carnivores, such as the lion and tiger, have to rely upon carbohydrate for their strength, just as the deer does for its fleetness. For even if carbohydrate be absent from the food, the body can, and must, manufacture it.

The drawbacks of carbohydrates are not grave. In too large amounts they may throw too great a strain upon the insulin-producing cells of the pancreas and induce diabetes. Further, as the cheap sources of carbohydrates are the cereals, and these contain salts which are fundamentally acid, a strain is thrown upon the kidneys in getting rid of the acid material. And, finally, they conduce, in the young, to rickets.

These drawbacks, as we shall see in the sequel, are easily surmountable. In spite of them carbohydrates will and should continue to bulk largely in our food.

It is excess only that is dangerous, and such excess is uncommon except perhaps in the diet of children.

(iv.) Roughage.—Indigestible carbohydrates of a different class have an important place in diet. These are the celluloses which form the fibres of vegetable foods. A modicum of them in the diet of all human beings after weaning is essential. The amount varies with age and individual. Every human being requires to eat some indigestible material, merely as a stimulant of the large bowel to healthy activity. Such material is conveniently termed "roughage," and its main source is the indigestible fibres of fruits and vegetables. Other indigestible material comes into the same category, *e.g.*, Russian oil or medicinal paraffin, which the alimentary tract cannot digest or absorb, and agar-agar, a preparation from Japanese seaweed. For most people, however, "roughage" is found in cellulose, *i.e.*, in bran,[1] and the fibres of green food and fruit.

[1] This sentence may conjure up in the minds of some people the idea that I mean them to be fed, like horses and chickens, on a warm mash. Most of us absorb some cereal husks in our morning porridge or in wholemeal bread. Others, because of the sluggish habits of their large bowel, take breakfast foods to which bran has been added. It is an amusing comedy: we pay to have all the bran refined away from our foodstuffs, and then, having paid the penalty in health for that, we pay to have it all put back again. A similar comedy is being played in the refining of salt. We pay three times over, and the economists tell us that man's paramount characteristic is self-interest!

Life without Roughage.—Sedentary life, rich and sophisticated food, laziness, and comfortable chairs conduce to a slackness of the large bowel, with manifold troubles as a result. The microbes seize on the stagnant food and manufacture poisons which are absorbed into the blood stream and upset the whole system. To such poisoning (toxæmia) half the ills of modern life have been attributed—headache, liability to infection with colds, tonsillitis and influenza, lumbago, depression, high blood pressure and hardening of the arteries—many of them with justification. Some scientists, such as Metchnikoff, have looked on the large bowel (colon) as a death-trap to those who possess it. Birds are notoriously long-lived: they have but a short colon. Sir Arbuthnot Lane has removed many a lazy colon, with benefit to the patient. Ellis Barker has attributed cancer to the absorption of poisons from that organ.

Without, however, going the length of these enthusiasts, it may be confidently asserted that the promotion of activity of the large bowel will save many a doctor's bill. The soundest way in which to do this is by natural and not by chemical means (*i.e.*, drugs). Foods containing roughage—oatmeal, green vegetables, salads, wholemeal bread and fruits, especially dried fruits such as figs, dates and prunes—will give the large bowel the stimulus it needs from within, and exercise will give it from without. Good

and regular physiological habits are also essential. If such simple measures do not produce the desired result it is time to consult a good physician. Quack medicines are taboo.

(v.) Salts and Inorganic Material.—With the natural swing of the pendulum attention is nowadays being turned to the simple mineral constituents of the diet. Originally it was the proteins that monopolised attention, then the energy value (see Chapter IV.), later the vitamins (see below, p. 87 *et seq.*), and nowadays mineral constituents are coming into their own. This is not to say that their value in food was overlooked in the past, but other subjects were more interesting, and loomed larger. To-day in the London clubs you may hear the medically inclined offering thanksgivings that the "vitamin stunt" is played out and that everything can be explained by the mineral constituents of food. (It cannot; but that is a detail.) This shows the trend of opinion. At a recent annual meeting of the British Medical Association a prominent researcher on the properties of food said: "Of the fifteen chemical elements which enter into the composition of the body, and are recognised as being essential, ten are mineral elements, and each of these ten is known to perform functions which cannot adequately be performed by any of the others. As all these minerals are continually being lost from the body in

the excretions, and all are required as constructive material in growth, it is obvious that the mineral content of the diet is of primary importance for the physiological well-being of the body." There is nothing in this paragraph with which to disagree. The mineral constituents are of vital importance, as the following paragraphs will show.

(*a*) Calcium is found in every tissue of the body, usually as some simple salt. Sixty-seven per cent. of the dried constituents of bone consist of mineral substances, and the largest proportion of this is calcium phosphate, with smaller amounts of calcium carbonate, calcium fluoride and magnesium phosphate. Teeth have an even higher percentage of mineral matter. Beyond these monumental masses of calcium compounds we find it present in and essential to the activity of every cell in the body. Without it blood and lymph will not clot. (It is essential that blood should clot to plug the hole in a damaged blood vessel.) Without it the heart will not beat, muscles become at first hyper-irritable and then palsied, nerves cease to conduct, and the thin walls of capillary blood vessels change in their permeability to the fluids within them. Moreover, in the absence of calcium in the milk this food will not clot when it meets the juices of the stomach. So important is calcium to the body that one set of "glands," [1]

[1] The technical name is "endocrine organs," or glands of internal secretion.

called the "parathyroids," is apparently set apart to govern the calcium content of the blood.

(*b*) Phosphorus, again, is found in combination either with other inorganic material, or with organic material throughout the body. In its native state it is highly poisonous, but when oxidised to phosphoric acid and held in combination it is a highly active element, and is responsible for energising many of the chemical reactions of the body. Phosphorus, as phosphates, is found in bones and teeth. The framework of the nucleus of the cell is built up on complex compounds of phosphoric acid. A compound of phosphoric acid and grape sugar seems to be the essential in evoking muscle contraction. Phosphorus, as phosphoric acid, enters into lecithin, an essential component of cells, particularly of marrow and nervous tissue. Finally, phosphorus is found in many proteins, such as caseinogen in milk and vitellin in the yolk of eggs. Clearly the body needs phosphorus.

(*c*) Iron is needed to make the red pigment of the blood. This substance, known as "hæmoglobin," is composed of (i.) a colour-bearing portion, and (ii.) a protein. The colour-bearing portion, hæmatin, consists of (*a*) iron, and (*b*) two portions of a coloured substance called hæmatoporphyrin. The combination of the three is essential. The red pigment of the blood has the function of carrying oxygen from the air in the lungs around in the blood to the tissues,

and the oxygen is attached to the iron. Without iron, hæmoglobin cannot be formed and oxygen transport in the necessary quantities is impossible.

It is possible that one form of anæmia called chlorosis (or the "green sickness") is due to an absence of iron from the food. At any rate, iron is an extremely useful medicine in treating the disease. Anæmia can certainly be produced experimentally by feeding young animals on food with little iron in it, and cured by adding iron or foodstuffs containing iron. Years ago Culpeper noted that watercress was good for people with the "green sickness."

(*d*) Chlorine, in the form of chlorides of sodium, potassium or calcium, is found in all tissues and is clearly essential to the body. No other salts can replace chlorides. If you deprive the body of common salt in its food, the remaining stores are treasured and the loss per day sinks from probably 10 or 12 grams to 0·1 or 0·2 grams, which loss seems to be unavoidable. That the body prefers to work with a greater turnover of sodium chloride per day is shown from the fact that after such sodium-chloride starvation is over, it does not return to the outer world all the salt which is eaten, but replenishes its depleted reserves. Other evidence of its importance to the body is the retention of chlorides during fever (especially in pneumonia), the salt being released directly the crisis is past. The concentration of salts in the blood markedly influences the way in which

hæmoglobin, the pigment of blood, loads and unloads its store of oxygen. Without salt in the blood the tissues would have trouble in obtaining the oxygen they need.

How much salt is needed per day is unsettled—taste is at present the best criterion. Certain it is that vegetarians will need more salt than mixed feeders. The need for " salt licks " for cattle is well known, and the explanation is that the potassium predominant in plant cells causes a loss of sodium chloride from the body, which has to be made up from the food and its condiments.

(*e*) Iodine. Mention has already been made (Chapter I.) of the need for iodine in the body. When it is deficient in the food, some children and animals are born cretins,[1] or later develop troubles of the thyroid gland.[2] The result is, in the long run, coarseness of skin, loss of hair, dullness of expression, apathy, low temperature, low food intake and turnover, and ultimately death.

In this country trouble with the thyroid (Derbyshire neck) is common in the deep valleys of the Pennines, Cotswolds and Mendips ; more rare on the West Coast than the East Coast, and absent near the sea. In such a town as Chesterfield, in Derbyshire, no less than 10 per cent., at the lowest computation,

[1] A condition of arrested growth and of deficient mental and sexual development.

[2] A butterfly-shaped gland in the neck, in front of the windpipe and just below the Adam's apple.

of the school children suffer from derangement of the thyroid gland.

The need is for iodine, which gives remarkable results in diminishing or curing and preventing the trouble. The body needs iodine for the manufacture of thyroxin by the thyroid gland, which controls the rate at which food is burnt by the body, and presides over the growth and changes of the body from infancy to adult life. Thus the rate of change in an animal from larval stage (*e.g.*, tadpole) to adult life (*e.g.*, frog) is hastened by iodine. In the changes which go on in the body between the ages of fourteen and sixteen thyroid secretion is needed, and therefore an increased iodine intake is demanded.

The source of this iodine is uncertain. Probably we get the small amounts needed in the sea air which blows over the country. This would explain the distribution of thyroid trouble in this country, particularly its presence in deep valleys, and also the undoubted benefit of the annual visit to the sea-side. Sea water and the things which live in it contain iodine. So, too, do many deposits of salt mined in different parts of the world. Presumably they resulted from dried seas. But in manufacture the iodine is refined away, and table salt contains no iodine. A certain way of obtaining it would be to go back to the old unrefined damp sea salt of our ancestors, or to purchase special iodised salt now on the market. Or we might utilise sea salt, in which

the calcium chloride and magnesium chloride have been turned into the phosphate. Such salt would not go damp on exposure to air.

Vegetables, particularly onions, are said to contain iodine, and also sea food, such as fish, lobsters and oysters. Seaweeds, too, are eaten as vegetables in Wales and Ireland, and plants from salt marshes, such as glass-wort. Cod-liver oil also contains iodine. The simplest way to obtain iodine, perhaps, would be to take iodised salt. Some countries (Bavaria) are making its use compulsory, and in the cantons of Switzerland a definite Government campaign has been instituted to persuade the people to use iodised salt for both cooking and table purposes. In this country such steps are probably not yet necessary, and, at any rate, the initiation of them should be left to the medical fraternity, which alone knows how widespread and important the incidence of thyroid troubles may be. One thing is certain—that prevention is better than cure, and the earlier steps are taken the better. Adolescents and adults do not respond to treatment as well as young children.

For the majority of people the problem is not urgent, and as long as a mixed diet containing some sea food is taken, iodine in sufficient amounts will be obtained by all.

The minimal requirements of these various minerals have been assessed as follows: calcium, 1·5 grams ($\frac{1}{20}$ oz.) as lime

daily; phosphorus, 3·3 grams ($\frac{1}{10}$ oz. approx.) as the higher oxide; iron, 10–60 mg. (1–4 grains); chlorine, as sodium chloride, at least 4 grams ($\frac{1}{7}$ oz.); and iodine, uncertain, though undoubtedly very small—perhaps 3 grams a *year*.

How, then, are we to make sure that we obtain sufficient of these substances per day? Fortunately, there are tables procurable of the mineral contents of various foods, and we can discover at once whether our diet is likely to contain sufficient of the various essential mineral constituents. Thus, as regards calcium, we learn that the substance richest in calcium is cheese with 1·1 per cent. of lime. No other substance comes near it in value, which, indeed, might be expected from a chemical knowledge of the clotting of milk with rennet. Egg yolk (0·20 per cent.), milk (0·168 per cent. oatmeal (0·13), cauliflower (0.17), celery (0·10), spinach (0·09), and carrots (0·077) may be considered rich, comparatively speaking, in calcium. Wheat and other cereals, bread, potatoes, oranges, tomatoes, etc., may be considered poor. To obtain the requisite 1·5 grams of calcium oxide (lime) per day from the richest source would need 136 grams, or nearly 5 oz., of cheese, while with oatmeal it would require 2½ lb.! *The wonder is that any of us obtains enough calcium per day. But it is best not to lose too much sleep over the problem, and assume that if the diet contains milk, cheese, eggs, and green vegetables the calcium intake will be sufficient.*

A similar state of affairs exists as regards phosphorus. Cheese contains 1·45 per cent. (as phosphorus pentoxide), egg yolk 1 per cent., meats about 0·5 per cent., egg 0·37, milk 0·22. Oatmeal, again, is high with 0·827, whole-meal bread 0·4, white flour and bread 0·2, green beans 0·27, green peas 0·26, cauliflower 0·14, and spinach 0·13 per cent. Much the same results come from these figures. *Milk, cheese, eggs, oatmeal and green vegetables should supply us with sufficient phosphorus.*

With iron affairs are slightly different. Milk is notoriously deficient in iron (0·00024 per cent.). Egg yolk (0·0085), meat (0·0038), whole meal (0·0053), oatmeal (0·0036), spinach (0·0032), green peas (0·0016). White bread and tomatoes contain but very little. In this list meat replaces

milk and cheese, but otherwise the list is much as before. Eggs, oatmeal and green vegetables supply us with the requisite stock of iron. One vegetable is interesting, viz., dandelion leaves. These, so much utilised as winter salad on the Continent and in Soho, contain nearly ten times as much iron as other green vegetables. They may prove a godsend in this and other ways in the future.

(*f*) Bases and Acids. There is one last consideration before we leave the mineral constituents, and that is the nature of the reaction of the ash of foods, whether acid[1] or basic. All through life acid waste products are being manufactured by the cells of the body and must be eliminated by the kidneys. When proteins are burnt in the body such acids as sulphuric acid and phosphoric acid are manufactured. The proneness to acidity of the blood is exploited by the vendors of patent medicines and neurasthenics. "Acidity" of the blood is doubtless very dangerous, though it is rarely met with outside the wards of a hospital. The blood must be kept just on the alkaline side, and if there be no basic substances in the food one, or all, of these things must happen: (1) the kidneys must work hard to excrete an acid urine, (2) ammonia will be utilised in small amounts to neutralise the acid produced in the tissues, or (3) the calcium carbonate of bone and the basic substances of the tissues will be drawn upon to neutralise the acid. None is particularly desirable, and the last very

[1] See Introduction, p. xi.

undesirable, especially in children (whom, by the way, the discussion particularly concerns). Much of the labour may be saved the kidney if a diet which yields basic residues on combustion be taken.

Roughly, foods may be divided into those which yield acid residues and those which yield basic. The former increase the work on the kidneys, the latter decrease it. To the acid producers belong the cereals and all animal foods except milk. To the basic residue producers belong all vegetables, especially beans, spinach, beet, carrots and parsnips. Again the vegetables are outstanding in providing the right kind of salts. It is upon them we chiefly depend for mineral substances. The market garden and the allotment save us from acidosis.

One problem remains for the careful householder. Do we obtain all the salts which the vegetables contain ? Possibly, if we eat them raw or as salads, but assuredly not if we boil them in large quantities of water, and throw the water away ! Vegetables need cooking " conservatively," *i.e.*, with little water, so that the soluble contents, salts and otherwise, are not lost. Otherwise the householder who provides plenty of milk, cheese, eggs, oatmeal, green vegetables and salad for the family need not fear that they will suffer from a deficiency of mineral matter in their food.

(vi.) Vitamins.—After crossing this rather arid

tract of mineral matter it is refreshing to come to the vitamins. These are, in the mind of the public, magic substances almost deserving of a headline in the popular Press. Their name, as originally spelt, was intended to mean that they belong to a definite chemical class of substances called "amines"—*i.e.*, substances closely related to ammonia—and that they are vital to existence. The former claim was due to exuberance, the latter is undoubted. To mark the fact that they no longer belong to any known chemical class they have been shorn of the "e" and have become vitamins; and there is a tendency, very much to be deprecated, among the high priests of their cult to shorten the vowel sound of the first "i" and call them vĭtămĭns, perhaps to suggest that they are found in victuals.

That there are such substances no researcher of any calibre who has worked on animal nutrition can doubt. Their results are so magical, when given to animals suffering from their lack, that one could be forgiven for thinking that the elixir of life had been discovered. One drop of an extract forced down the throat of an animal moribund because vitamins were lacking in the diet will result in a marvellous cure—the animal becoming, in twenty-four hours, as lively as a cricket and as though it had never been in *articulo mortis*.

Their chemical nature is not known as yet, partly because they are present in such minute amounts

in any given foodstuffs. It needs a small fortune and apparatus on a manufacturing scale to isolate the few grams weight of substance necessary for a rigid chemical analysis. The vitamin in a hundredweight of foodstuff may easily be concentrated in a tablespoon, and even then the substance will not be pure. At present the research worker on nutrition has to be content to use impure solutions of vitamins—*i.e.*, solutions which, while they do contain the vitamins in concentration, nevertheless contain many other substances, too.

Enough is known about them to render it more than a conjecture that they belong to the class of substances known as catalysts. These are substances which bring about or hasten chemical reactions, which otherwise would not take place, merely by their presence. Thus carbon monoxide—a poisonous gas forming a considerable percentage of coal gas—unites explosively with oxygen ; but only in the presence of water vapour. At the end of the explosion the water is still there and unchanged. It has acted as a catalyst. Similarly, with nearly every chemical reaction, it can be hastened by the presence of some other substance which none the less is unchanged. Catalysts, as it were, oil the machinery of a chemical action ; they put the reagents in the right mood for combination.

Vitamins apparently act in this way. They facilitate the deposition of lime in bones, or they aid

the manufacture of milk protein from its constituent amino acids. By so presiding over some of the normal reactions of the body they prevent the necessary changes from moving in a morbid direction. As these morbid directions end in definite diseases, such as rickets, beri-beri, and scurvy, it is natural that each vitamin has the term "anti" attached to it. It wards off rickets, and is therefore called "antirachitic"; or beri-beri (one of the symptoms of which is an inflammation of the nerves) and is called "anti-neuritic"; or scurvy, and is called "anti-scorbutic." But the simplest terminology is that of vitamins A, B and C, this being purely provisional and not begging any question as to whether they are simple or mixed substances or their function is to "ward off disease" or bring about definite chemical reactions.

The history of the discovery of the vitamins illustrates one important thing in nutritional research, and that is, though vague ideas of there being something not protein, fat, carbohydrate or salts, which was a necessary adjunct of food, had been current for over a hundred years, no real advance was made till rigidly controlled experiments upon animals were instituted.

It was natural, in spite of vague intimations to the contrary, for physiologists of the late nineteenth century to assume that animals ought to be able to live indefinitely on a diet of pure protein, fat, carbo-

hydrate, salts and water. So when it was found that they would live on a digest of natural protein (see p. 62), but not on an artificial mixture of amino-acids, it gave some researchers food for thought. Mice, it is true, lived longer on zein to which tryptophane was added than they did on zein alone. But they ought to have carried on almost indefinitely.[1] Substances such as the lecithins were beginning to evoke general interest at that time—might they not be essentials in diet ?

The really important pioneer work did not appear till 1912, though it was much earlier in conception and actual experimentation. As the work is of classical importance, and will be quoted whenever the vitamins are discussed for the next hundred years, the fundamental experiment is given here. Eight young growing albino rats were given a diet made of pure protein (caseinogen), fat, carbohydrate and salts and water, and weighed every day. Another group of the same average weight was given the same diet, but in addition, and at a different time in the day, a small amount of good milk. As will be seen from the figure, the two groups of animals grew at entirely different rates. The ones on the pure diet, without the milk, grew poorly for a few days and then declined. In eighteen days they had gained but a few grams in weight. Their colleagues, on the

[1] Subsequent discoveries showed that zein possessed too little lysine for this to be absolutely true.

other hand, had gone ahead, and on the eighteenth day had increased their weight by some 30 grams each (over an ounce), and as they started the experiment weighing only about an ounce and a half, this

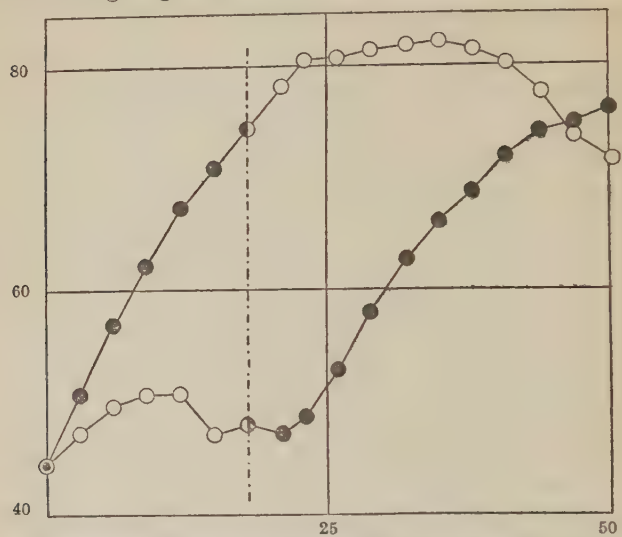


FIG. 3.—GROWTH CURVES SHOWING THE IMPORTANCE OF ACCESSORY FACTORS IN A DIET.

Lower curve (up to eighteenth day), eight male rats upon pure dietary; upper curve, eight similar rats taking 3 c.c. of milk each a day. On the eighteenth day, marked by vertical dotted line, the milk was transferred from one set to the other. Average weight in grams vertical; time in days horizontal.

was no mean gain. On this day the diets were changed over; those which had not received the milk were now allowed to have it, and those which had received it were now put on the basal dietary of purified foodstuffs only. The effect was almost instantaneous. Those which had grown well now

grew more slowly and then began to lose weight. The others, transferred to the basal diet together with milk, now grew rapidly, and when the experiment concluded had overtaken and passed their colleagues on the basal diet.

There was (and is) therefore something in the milk upon which the well-being of the animals depended. It is not the energy value of the milk, for that was but some 4 per cent. of the total energy value of the food. Starch, fat, protein, sugar, all of which produce energy, could not take the place of the milk. Further, other things producing much less energy could take its place, viz., juice of swedes, or a minute amount of yeast. There is something in the natural food which has been purified away from the foodstuffs used for the basal diet, and this " something," Sir Gowland Hopkins, to whom we are indebted for the work, was content to call " accessory food factors," meaning by this they are accessory to the proteins, fats, carbohydrates, salts and water which, until then, were thought to be the only essential foodstuffs.

This work, simple as it may appear, threw an almost blinding light on some problems which had intrigued physiologists and medical men for many years. There was the disease scurvy, known to be due to the consumption of a diet restricted to pickled meat and ships' biscuits, and curable by fresh fruits and vegetables. There was beri-beri, a disease of the

Far East, suspected of being a dietary disease. Nearer home there was rickets, so rife in this country. Diet is a factor both in the production and cure of rickets. Might not all these diseases be due to the absence of some one or other accessory factor from the diet of the sufferers ? Such an idea had already crossed the mind of Hopkins some years before the publication of his fundamental work, and the prediction of this seer among researchers has been abundantly justified. Let us take the evidence from the history, discovery of the cause and cure of these typical diseases, scurvy, beri-beri and rickets, and show how they fit into Hopkins' conception of accessory factors.

Early in the eighteenth century scurvy had already seriously occupied the minds of medical men. Not only was it rife in the early spring each year in the more northerly parts of Great Britain, but it was a serious handicap to our commercial life, for our sailors, on the slow-sailing vessels of the period, with their protracted voyages, suffered badly from it. Nor is it unknown to-day, for in the late War our Indian soldiers suffered from it in Mesopotamia, it appeared in camps in France, and our men saw much of it among the Russians in Murmansk. Tales from the Arctic and Antarctic have made us familiar with its name, for Shackleton, Scott and Evans all had to contend with this terrible disease. Its early symptoms are headache, dizziness on suddenly rising

from a stooping position to the vertical, lassitude, gloom, irritability and proneness to condemnatory and uncalled-for argumentativeness! Later there is soreness and bleeding of the gums, swelling and pain in the joints, looseness of teeth in their sockets, and hæmorrhages under the skin. Then the teeth begin to fall out, the gums recede, become waxlike and capable of being cut with a toothpick. There is great anæmia, muscular weakness, dilatation of the heart, and death ensues after a period of delirium and convulsions.

All this had been seen many a time, and indeed may be familiar to many of us who have had friends in the Army during the War or on Arctic and Antarctic expeditions, or even in railway construction camps in the backwoods of Canada.

It has been known for years that fresh fruit and vegetables cure the disease in a miraculous way. There are tales of sailors too ill to eat cured by the solicitude of their comrades, who managed to squeeze the juices of onions down their throats. The first sound experiments were made by Lind, who published in 1757 a "Treatise on the Scurvy." He had twelve sailors in his charge, all stricken with scurvy. Dividing them into six pairs, he gave each pair a definite treatment, ranging from a pint of sea-water a day, through sundry types of physic—garlic, mustard seed, balsam of Peru and myrrh—up to two oranges or lemons a day. The fortunate pair who

had the oranges and lemons were so far recovered by the time the ship reached Plymouth that they carried their sick comrades ashore—this though the oranges ran out of stock after six days only.

From experiments such as this grew up the belief in the efficacy of fruits of the orange and lemon type—lime-juice made from Mediterranean limes proved a specific, and able-bodied sailors, when they signed on for another voyage, had to agree to take so much lime-juice per day. They may still have to do so, though the ground for it has disappeared, and to most people the ritual is meaningless. But lime-juice proved a bitter disappointment to Scott, who found it useless in his first Antarctic expedition. Others had also reason to doubt its efficacy, and there grew up an idea that scurvy was due either to microbes, acidity of diet, decomposition of meat, or to constipation. But the older theory was true all the time—scurvy is due to the deprivation of fresh fruits and vegetables, which contain "accessory factors." Not all fruits and vegetables contain them, nor are they present in the same amount. The lime-juice failed Scott and others because it was made from West Indian limes, which in their fresh state yield little of the necessary factors. None is present when the juice has been sterilised and bottled!

In elucidating the problem of scurvy, animal experimentation has proved of the utmost value.

It was discovered in 1907 that guinea pigs are susceptible to scurvy and develop it on a diet of oats, bran and sterilised milk. To add substances to be tested for their anti-scorbutic (scurvy-preventing) power is simple, and to-day we have a vast accumulation of facts upon the subject. Suffice it that when Hopkins published his paper on accessory food factors it was known that scurvy could be cured by " something " in the juices of many fresh fruits and vegetables.

The same was true of beri-beri.[1] This is a disease which had but little interest to most of us until the War. Then sundry of our friends either suffered from it or saw others suffering from it in Salonika and Mesopotamia. Empire builders met it in the Malay Peninsula among the natives. But, more nearly at home, it has been seen among Norwegian sailors, and our cousins in our oldest colony, Newfoundland, and in Labrador, have from time to time suffered from the disease.

Its symptoms are due to widespread destruction of the nerves, both of motion and sensation. Hence

[1] An ununderstandable confusion of *beri-beri*, a dietary disease, with *ngana*, sleeping sickness, occurs in the minds of the public. And now there is a disease, called sleepy sickness, or *encephalitis lethargica*, which has added a further confusion.

Beri-beri is a disease of the Far East and is due to faulty diet; *ngana* is a disease of Equatorial Africa, due to a visible micro-organism transmitted by the bite of the tsetse fly; *encephalitis lethargica* is a disease which has recently appeared in Western Europe, and is due to a microbe invisible under the ordinary microscope.

it is called polyneuritis. There is fatigue and depression, numbness of the skin and stiffness and paralysis of the muscles. These increase in extent and intensity. There is, moreover, disturbance of the alimentary tract, and of the heart. Death is often sudden and from heart failure. Again the disease exhausted the gamut of theories : it was due to microbes, to too little fat in the diet, to arsenic. They were all wrong. By the time of the publication of Hopkins' paper it had been shown that fowls and pigeons could suffer from the same disease and that there were sundry parts of foodstuffs (the bran of rice and wheat) and other substances which could ward off this disease. There are, indeed, factors accessory to protein, fats, carbohydrates and salts, which catalyse the reconstruction of nervous tissue, so that in their absence the nerves go to pieces and the sufferer dies.

Finally, there was rickets. Hopkins had already foreseen that perhaps " accessory factors of food " were essential in preserving the growing child from rickets. This disease has its chief manifestation in faulty deposition of calcium in the growing bone. But in addition the child is nervous, irritable, apathetic and disinclined to play. His muscles are loose and flabby and the alimentary tract is sluggish. There are head sweats, anæmia, protrusion of the abdomen and bowed legs. The child exhibits a tendency to colds in the head, bronchitis and broncho-pneumonia.

Rickets is by no means a disease only of the poor. Mayfair and Belgravia may easily suffer too. But it is a disease of diet, and though cures can be effected by changing the diet, they are not so rapid and magical as those for scurvy and beri-beri. Cod liver oil has long been known as a specific for rickets. Now, cod liver oil is a remarkable fat. It has the capacity of altering the state of a child within a few hours, from dullness and disinterest in food to playfulness and a good appetite. It will clear up recalcitrant colds and malaise. All this suggested that in addition to its fat it has some "accessory factor" of vital importance to the body.

Physicians remembered, in the light of these suggestions, another curious disease due to faulty diet: an ulceration of the eye. This was first described in Japan, but it has been seen in Denmark during the War, and in Russia and Austria since the War. Cod liver oil is the specific for this disease, which clears up marvellously after but a very short treatment. Possibly here was proof of another accessory factor at work?

From 1912 onwards there has been almost an orgy of work on "accessory factors" by researchers, good, bad and indifferent, all over the world, but especially in Great Britain and the United States. The results go the whole way to justify Hopkins' belief in the necessity of "accessory factors" in human and animal nutrition. The following is an

account of the present state of beliefs of the nutritional world upon the problem and its application to feeding the family and the nation.

The "accessory factors" have been christened "vitamins," and the name has been accepted by the scientific and lay Press alike. Many other names have been suggested, but none adopted. The vitamins are not all of the same class, but may be divided into three groups, provisionally called A, B and C. The reasons for differentiating them are (i.) their effects on the body; (ii.) their solubilities in different reagents; (iii.) their distribution among the foodstuffs; and (iv.) their resistance to oxidation and temperature.

Vitamins of Class A.—Of these there may be two, one presiding over growth and guarding against the eye disease, keratomalacia, mentioned above, and the other influencing the deposition of calcium salts in the bones and teeth and preventing rickets. Originally they were thought to be one and the same vitamin, but there are slight differences in their distribution and powers of withstanding oxidation. Those who accept this differentiation call them the anti-xerophthalmic or anti-keratomalacic vitamin and the anti-rachitic vitamin, or, more simply, vitamins Ai and Aii.

They occur together in fats, particularly animal fats. They are made by plants and can be dis-

solved from plant products by means of things which dissolve fats. Animals eat the plants and store the vitamin A in their fat. As this class of vitamin easily dissolves in fats, it is often called fat-soluble A. The richest source of vitamins of class A is the liver fats of fish (*e.g.*, cod liver or herring liver oil). A long way after this, as a source, come milk and milk fats and things made from them (cheese, cream and butter). With them may be classed most animal fats—though lard is practically devoid of vitamin A—and many green vegetables. Vegetable oils have little vitamin A, though none, except olive oil and linseed oil, seem completely devoid of it. Consequently, though margarine made from animal fat has some vitamin A in it, the cheap varieties made from vegetable oils have little or none. Cereals and cereal products are deficient in vitamin A.

Without these vitamins in food, growth is slowed and may entirely cease (human beings and albino rats); eye trouble develops (man, albino rat, fowl, horse); and rickets, if the animal be young (children, puppies, rats, lion cubs) will ensue.

Very small amounts are sufficient to protect the body. One drop of a concentrate from cod liver oil (probably by no means pure vitamin A), will be more than sufficient for a child each day. One teaspoonful of cod liver oil is sufficient for a growing child per day to ward off rickets, and it acts because of the

vitamin Aii, which is there in less concentration than one part in two thousand!

Vitamin A is resistant to temperature as long as no air is present. It will withstand a temperature of 120° C. (*i.e.*, well above the boiling-point of water), as long as air is excluded. If air be bubbled through the melted material the vitamin is rapidly destroyed —in sixteen hours not a trace is left. Aii is more resistant than Ai. This has particular interest in the cooking of food. Probably frying in an open pan destroys some or all of the vitamin A present in the fat; but it is doubtful if any harm accrues to the vitamin in milk when it is boiled or to that in fat in the middle of a boiled suet pudding.

Vitamin A is obtained in the food of anyone who can afford milk, cheese, butter, animal fat, green vegetables, carrots, tomatoes and the oily fishes. Some, if not all, of these are, as we shall see in the sequel, economical foods. Certainly a diet without vitamin A would prove a most uneconomical diet. But with wise marketing, vitamin A is purchasable even by the poorest of us.

Vitamins of Class B.—So far but one has been postulated by most research workers. This presides over whatever type of metabolism it is which preserves the nerves from destruction. It has, moreover, a curious relation to the assemblage of amino-acids necessary when protein is being manufactured. A

nursing animal is manufacturing in its milk glands the protein caseinogen. To do this adequately it needs more vitamin B than usual, especially if the proteins in the foodstuffs be in excess. The milk of an animal given much protein will poison its young, if together with that protein extra vitamin B be not given. This has a distinct bearing on the diet of the nursing mother which will be brought out later.

Vitamin B occurs in a totally different range of foodstuffs from vitamin A. It is found in the bran of wheat, and therefore in wholemeal (brown) bread and biscuits ; in the husks of all cereals and, therefore, in oatmeal porridge ; in yeast, and therefore in (white) bakers' bread, though not in beer and wine ; in many vegetables and fruits, *e.g.*, beans, peas, carrots, potatoes and oranges ; in egg yolk (superabundantly), and liver, heart, and milk in smaller amounts. Foodstuffs defective in vitamin B are highly milled cereals and canned foods.

Vitamin B is resistant to temperature unless it be above the boiling point of water. Then it is slowly destroyed. At 120° C. the destruction is much more rapid, and so no canned meat or vegetables contain any appreciable amount of vitamin B. Ordinary cooking, however, does not destroy vitamin B to any harmful extent. In view of the range of foodstuffs in which vitamin B appears, there is little danger that it will be omitted from the dietary of any ordinary person in Great Britain—the

nearest approach made to the danger point will be amongst the very poor, with their food restricted to white bread, margarine, jam and tea. The white bread, because of the use of yeast in making it, will contain some vitamin B, though none of the rest of the food does. Deplore such a diet as we may, because of the poverty of its proteins, the lack of roughage, salts and vitamins A and C, it probably contains sufficient, if minimal, amounts of vitamin B. At any rate, there are no outspoken symptoms of beri-beri among the poor. At the worst, they must be present in a subacute form only.

When the diet is restricted to biscuit made of white flour, the appearance of beri-beri is frank, as happened in the Siege of Kut. Then the diet had to be supplemented with a source of vitamin B, and a yeast preparation known as Marmite was given with beneficial results. If there are any young women to-day who do as Robert Louis Stevenson says most young women in his day did when left to themselves—live entirely on tea and cake—they will certainly suffer from beri-beri. But accounts from all sides maintain that the Victorian type of young lady, even the emancipated type, is defunct!

Vitamins of Class C.—Again, no more than one vitamin of this class has been discovered. Its function in life is to protect the body from scurvy. Not all animals need it—the albino rat can go for

generations without it—but the guinea-pig is very susceptible to scurvy. Man takes an intermediate position. With him the deprivation of vitamin C has to be of long standing (*e.g.*, the winter through) before symptoms of scurvy become pronounced and recognisable. This is not to say that he has not suffered before the acute onset of the disease. Most of us, at one time or another, have suffered from "dizziness on standing erect after stooping, laziness, irritability, gloom, despondency and a proneness to condemnatory and uncalled-for argumentativeness." While this may be due in most cases to an incipient cold or bilious attack, or to intestinal stasis—witness the effect which an aperient often has on such symptoms—it is possible that part of the time it is due to incipient scurvy.

Vitamin C has a different distribution from either A or B. It is present in fruits and fresh vegetables, especially in oranges, lemons and tomatoes and in vegetables of the cabbage variety. The foodstuffs notoriously lacking in vitamin C are cereals and foods made from them (bread, cake, biscuits), all tinned goods,[1] all dried fruits and vegetables, and commercial lime-juice. Apples and grapes are disappointing. Milk contains enough for a baby. Fresh meat, though not salt meat, contains traces (Eskimos get their vitamin C from meat).

Vitamin C, unluckily, is sensitive both to heat and

[1] With the exception of tinned tomatoes.

oxidation. It is, indeed, the most easily destroyed of the three. Exposure to the temperature of boiling water for an hour destroys 95 per cent. of the vitamin C in cabbage. The drying of vegetables has the same effect, as was found, terribly to their cost, by the armies in the American Civil War. Once-pasteurisation of milk seems not to affect the vitamin C, but twice-boiled milk is said to have none. Moulds on fruit destroy its vitamin. In fact, the freshness and soundness of fruit and vegetables are their only guarantee.

Vitamin C is thus the vitamin which is most likely to be absent from one's diet, especially in the winter and early spring months. Once scurvy was prevalent in the north of England and Scotland every year in those months, but the spread of the culture of green vegetables and the penetration of oranges and lemons, and later of tomatoes, into all parts of the country now prevents that.[1] None the less, it is wise to take precautions. All children brought up on dried milk need a teaspoonful or two of orange or tomato juice per day. Salads should be provided in every household once a week during winter and early spring

[1] It is an interesting speculation as to why scurvy does not appear in the frost-bound parts of Canada and Siberia. A five months' winter makes the supply of green vegetables precarious, but Canada imports oranges, lemons, grape-fruit and salad, and, moreover, uses salad made from raw cabbage stored as we store roots. Siberians, I am told, eat much raw *sauerkraut*. Seeds (peas, beans and wheat) sprouted in gentle heat could be used as a source of vitamin (C) in such countries.

—raw cabbage makes a welcome change from lettuce (see footnote, p. 106). Lemonade made from fresh lemons with cold water is another admirable source of vitamin C.

It is not in the ordinary household so much as in institutions that special precautions are necessary to ensure the presence of vitamin C in the diet. Vegetables are apt to be cooked over-long on account of the difficulty of dishing so much up at one time. Stews are popular both with inmates and staff, and the vegetables go in with the meat and are effectually deprived, by the long boiling, of their vitamin C. Fresh salads are a trouble to prepare and keep unwilted before the time comes for eating them. Fruit, even an orange apiece once a week, runs up the housekeeping expenses. The caterer at the head of an institution has no easy time, so that it is little wonder that scurvy sometimes breaks out in almshouses, prisons and workhouses. If it were not for the omnivorous habits of schoolboys and their passion for " tuck," scurvy might easily appear in our public schools. It is the duty of the housekeeper-caterer of such institutions to guard against troubles due to diet, and to do this, especial watch must be kept on the vitamins.

To sum up, the fascinating study of the " accessory food factors " or vitamins, we may say that, while a diet *must contain protein, fat, carbohydrates, salts and roughage, it must, in addition, contain factors accessory*

to these, viz., *the vitamins*. These substances are present in minute amounts in many foodstuffs, but not in all. There are three classes of vitamins, the first of which is associated with animal fats, particularly with the fat of fishes, and with green vegetables ; the second with the bran and germ of cereals and with yeast, and to a lesser extent with fresh fruits and vegetables ; and the third with oranges, lemons and green vegetables. Practically no one foodstuff, with the exception of tomatoes and milk, contains all three vitamins. All sophistication of foodstuffs, *e.g.*, the milling and bleaching of wheat flour, the manufacture of jam, the preservation by means of salt, canning or drying, destroys or removes the vitamins which otherwise they would contain. It is essential, then, to choose one's foods with circumspection, but it may be said that a *diet which contains milk, butter, cheese, eggs, fresh fruit and vegetables—especially if served as salads—will contain not only all the vitamins necessary, but the proteins, fats, carbohydrates, salts, and roughage which are essential to the body.*

CHAPTER IV

FOOD AND ENERGY.

"Vitai lampada tradunt"

TO the poet, the phrase the "lamp of life" must seem out of place in a book dealing with a scientific problem—perhaps even offensively out of place. To the materialist it may appear fantastic and absurd. None the less it is warranted. The physiologist has long seen the poetic analogy between the candle flame and life, and perhaps to the mind of the poet has debased the symbol by showing its actuality. Just as the candle consumes its material in giving light and heat, so does the body consume itself in maintaining life. The candle flame is extinguished in air from which the oxygen has disappeared; the flame of life is similarly extinguished. The material of the candle combines with the oxygen of the air and produces heat; the material of the body, either of its intimate structure or its store products, combines with oxygen to produce heat or other forms of energy, for heat and mechanical work are only forms of the same indestructible thing, energy.

The Fireplace of the Body.—Where, then, is the flame of life ?

> "We cannot kindle when we will
> The fire that in the heart resides."

sings the poet. But it is not in the heart, nor in the lungs, as Lavoisier, the first of modern chemists, thought, but in every living cell of the body—in the nerve cells of the brain, the fibres of the heart muscle, the units of the secretory glands. Each in its way is a slow combustion furnace, consuming the fuel which was once food, and by the energy of combustion creating new substances, recreating the chemical machinery for muscle contraction, and keeping up the heat of the body. Without warmth, the processes of the body slow down and ultimately cease. Warmth is the first condition for vital processes in man, so warmth must be created. Muscular energy —mechanical work—is a prime condition for our continued existence in a world of threatening circumstance. Muscular energy must be created. Both warmth and muscular energy come from the burning of food in the cells of the body. As an engine burns coal and transforms the energy of oxidation into mechanical work and heat, so does the body, in its furnaces, the cells, burn food and transform the energy of oxidation into mechanical work and heat.

The Heat Unit.—Energy production depends on

food. We can, therefore, rank foods according to their ability upon oxidation in the body to yield energy, and, as heat is a form of energy, we can measure the capacity of food for yielding energy in terms of heat. Hence the term "calorie," so upsetting to the lay mind in books upon food. The term "calorie" [1] is simply a measure of heat—it is the unit.

Engineers are familiar with the fact, and so to-day are most householders, that some fuels yield more heat per pound than do others. Thus soft coals will yield less heat per pound than a good grade of anthracite. Anthracites, too, differ among themselves as to the heat they will yield. So the wise engineer tests his fuels, compares the heat they will yield per pound, and then sees which will be the most economical to use. Thus one grade of anthracite at 80*s.* the ton may yield so much more heat than one at 60*s.* the ton that it may be more economical to buy the expensive grade. So with foods. They vary widely in the amount of energy they will yield when burnt in the cells of the body, and, as we shall see in a later chapter, some are economical as fuel foodstuffs and others are dear. To measure the fuel value of foods we need a unit; to understand the estimation of the heat energy available in the oxidation of foods, a brief exposition of the technique of estimation and its outcome is essential.

[1] From the Latin *calor* = heat.

The Heat Energy of Foods.—The unit used is the great calorie. If we take a litre of ice-cold water (about a quart) and heat it all the way to boiling point, we have put a definite (and constant) amount of heat into it. This heat is 100 great calories. If, instead of heating the water through 100° C., we had heated it through one only, on the Centigrade scale, we should have put but one great calorie into the water; if through 20° C., then twenty great calories, and so on. Similarly, twenty great calories will warm 20 litres through 1° C. To do this we might have burnt gas, or wood or coal or even dry bread. The rise of temperature when a pound of each was burnt would measure the capacity for production of heat on burning of each of these four substances. Thus, when we say that the calorie value of bread is 1,056 great calories we mean that when a pound of it is burnt in and by the body it warms the body to the extent of 1,056 great calories. The calorie value of milk per pound (four-fifths of a pint) is 310 great calories; of potatoes per pound, 296; and of butter, 3,410. Foods, obviously, vary greatly in their heat-producing capacity; some yield negligible amounts per pound (*e.g.*, asparagus, 96), others relatively enormous amounts (*e.g.*, fats, 3,400). To know and to be able to utilise the amount of valuable data concerning the calorie values of foods is of vital importance to everyone who is in charge of the

feeding of a family, an institution, such as a school, a hospital or a college, or of a nation. (This last may seem to some an extravagant claim. None the less, during the Great War, the calorie value of foods was of the utmost import and concern to every Government of every nation engaged. In this country a committee of the Royal Society was appointed to deal with the problem, and its recommendations, which were adopted by the Government, had much to do with the eventual success of the Allies. It is not too much to say that the ultimate collapse of Germany and Austria was due to the inability of the Governments of those countries to supply food of sufficient calorie value to the people.)

The fundamental fact in all work on measuring calorie values is that energy is indestructible. It does not matter whether fuel is burnt with an obvious white hot flame or more slowly, so that the temperature of the " burning " mass is but little above that of the surrounding air. It does not matter where or how the fuel is burnt, or in what stages. As long as the material is all consumed to the same state, the total heat given out is the same whatever the processes are through which it has gone. Thus we might burn a pound of house coal and measure the heat produced ; or we might coke it first, burn the coal gas which comes off, and estimate its heat of combustion, and then burn the coke and measure, in its turn, the heat produced. The sum of burning

the fuel in two stages (allowing for the heat we put into the coking of the coal) will be the same as in burning the coal direct. So with foods. Whether they are burnt all at once in a machine called a calorimeter (a calorie measurer) or by slow stages in the body, the result is the same if the end results of combustion are the same.

Burning Foods in the Body.—Now, it is easy to burn, say, sugar in the calorimeter and measure the heat given off. We weigh out a portion of sugar, put it in a steel bomb, pass in oxygen under high pressure, immerse the bomb in a known amount of water, fire the sugar by means of an electric current, and measure the heat given off to the water. With a human being the problem is a bit different. We put him in a small room, 9 feet $\times$ 6 feet $\times$ 6 feet, and keep him there for some hours or for a day or more! The room has copper walls and is carefully insulated from the rest of the world by being inside another slightly larger box. The walls of the first room have a series of pipes conveying iced brine through them. When the man burns food in his body (which, of course, is all the time) he warms the air around him and this warms the walls of the copper box. In turn, the brine is warmed, and by circulating the brine at a known rate through the pipes, we can measure how much heat it receives from the man. The quantity of brine warmed multiplied by the tem-

perature rise gives the heat given out by the man during the experiment.

But how do we know what he has burnt ? From the nitrogen secreted in the urine we can gauge the protein he has burnt ; from the carbon dioxide and water output and the oxygen intake we can gauge the fat and carbohydrate he has burnt. Moreover, we can measure the calorie value of the food he has eaten while in the apparatus by burning samples in the steel bomb, and also the calorie value of the excreta by drying them and burning them in the bomb. The calorie value of the food minus the calorie value of the excreta should equal the calorie output of the man while in the apparatus. They do to within the error of the apparatus ! Man, as shown by this experiment, burns food just as it can be burnt in a calorimeter, and this fact saves us endless trouble. It means that instead of shutting a man up in a copper cage for days at a time when we want to measure the calorie value of a food, and then not being quite certain that the fellow had burnt the exact particles of food we meant him to burn, we can carry out the experiments in a few minutes with the steel bomb.

There is but one slight difficulty. Whereas man, like the bomb, burns fat and carbohydrate till they become carbon dioxide and water, he does not burn protein quite so far. He burns protein until it is urea, a substance which itself will burn in air. He

does not obtain all the heat possible from protein, partly because when you burn protein completely you get nitric acid, one of the most violent and destructive of the acids. It would hardly do to manufacture *that* in the body. Careful estimates of the calorie value of the end products of the combustion of protein in the body show us that out of the possible 5·6 units of heat obtained by burning protein, the body avails itself of 4·1 only.

An example from industry may make this clear. An engineer could burn the gas from coal and throw away the coke. It is clear that he would not get as much heat from the coal as if he burnt it all, gas and coke. Some such thing the body does. It burns proteins to carbon dioxide, water and urea, and then throws away the urea. The urea would burn, too, but the body does not dare to do it.

To make a long story short, the body, by burning a unit by weight (1 gram) of protein, obtains 4·1 great calories; of fat, 9·3 great calories; and of carbohydrate, 4·1 great calories. [In ounces, 1 oz. of protein or carbohydrate yields 116 great calories, and 1 oz. of fat yields 264.]

Knowing this and knowing the percentage composition of the foodstuffs, you can calculate the calorie value.[1]

[1] Thus, if a foodstuff have 5 per cent. protein, 10 per cent. fat, and 50 per cent. carbohydrate, the rest being water, its calorie value will be for every 100 grams, $5 \times 4{\cdot}1$ (from the protein) $+ 10 \times 9{\cdot}3$ (from the fat) $+ 50 \times 4{\cdot}1$ (from the carbohydrate). These add up

Tables of Heat Values of Foods.—Fortunately for most of us, this sort of tedious calculation has been spared us. There have been published for the benefit of the public complete analyses of all sorts of foodstuffs together with the calories available per pound of the foodstuff. The most comprehensive list was compiled by Atwater and Bryant [1] for the United States Department of Agriculture, at the low price of 10 cents (about 6*d.*). It is easily obtained by sending American stamps, value 15 cents, procurable at Thomas Cook & Sons, to the Government Printing Department, Washington, D.C., U.S.A. The British Government has also a publication to its credit: "Analyses and Energy Values of Foods," by R. H. A. Plimmer, published by His Majesty's Stationery Office, Imperial House, Kingsway. This volume is supplementary to the publication of the United States Department of Agriculture, is more sumptuously produced, and costs 6*s.* The task of the British householder who would think of food in terms of calories is somewhat hard and costly.[2] It is wise,

to 318·5 calories per 100 grams. But a pound avoirdupois weighs 453·6 grams. A pound will therefore yield 318·5 × 453·6 ÷ 100, and that is 1,444 great calories.

[1] "The Chemical Composition of American Food Materials," Bulletin 28, U.S. Dept. of Agriculture, Washington.

[2] In the United States and Canada things are made much easier for folk who, like Miss Dartle, "want to know, you know." In all the big towns there are a number of standardised restaurants (Child's) something after the fashion of Lyons. The calorie values of standard servings of most of their foods have been published and are now, I

however, to make that effort, as, it is hoped, will be shown in the next chapter. Nor is it at all difficult once a beginning is made.

One of the main functions of food is to supply energy to the body, just as the function of fuel in a steam-engine furnace is to be burnt and supply energy to the machinery. No engineer feels it in the least degree foolish or undignified to discuss the energy value of the different fuels he may use. Such and such a material yields so many British thermal units per pound when burnt and has such and such advantages in the way of storage space and economy. In the same way, the person who wishes to understand the relative values of foodstuffs to the body should know how many units of energy are obtainable by burning the different foodstuffs in the body. What is wisdom for the engineer in running his engine with economy and efficiency is wisdom for the caterer in the home in running the engines of the human body.[1] There is no need for ignorance of the matter. The calorie values of the different foods are available for the anxious enquirer, and the calculations which may be necessary are simple to anyone who can add,

believe, actually printed on the menu. Battle Creek Sanatorium regularly does the same. This will doubtless raise a smile on the face of the average Briton, but I can testify the value of the information to one poor Englishman who found himself stranded with but a little reserve of cash in the city of Toronto!

[1] The writer has always found that the readiest listener to a statement of the calorie point of view of food is the engineer

subtract, multiply and divide.[1] The actual daily calorie rations for the average man and problems in economy in calories are treated in the next two chapters.

Summarising this chapter, we may say that the figurative expression "the flame of life" can be accepted in the study of food in a literal sense. Food is burnt like fuel in the engines of the human body. As a knowledge of the heating values of fuels is necessary to the engineer, so is the knowledge of the heating power (calorie values) of foods necessary to anyone who wishes to stoke the engines of the human body with efficiency and economy. The data upon which to work are easily available and need at the most but a little simple arithmetic.

Note on the Use of Calorie Tables.—The compilers of the tables of calorie values have put a queer obstacle in the way of the practical person. Everything is given in calories per pound. At once the housekeeper is up against milk and eggs, olive oil and oranges, and such like which are not sold by the pound. How is she, without scales and counterpoises and what not, to know that an average egg weighs 2 oz., so that one egg should yield 82 great calories, and that a pint of milk weighs approximately 1¼ lb., so that a pint of milk should yield 378 great calories? One tablespoonful of olive oil weighs ⅔ oz., and so yields 100 great calories, one tablespoonful of vinegar weighs ½ oz. and yields 5 great calories. Therefore a French salad dressing made of two tablespoonfuls of olive oil and one of vinegar should yield 205 great calories.

[1] People who, like the author, cannot do simple arithmetic should use logarithms or the slide rule.

Probably the very best way of thinking in calories is to learn to visualise the 100-calorie portion. As an aid to this, the following data are given :—

The 100-Calorie Portion.—One hundred great calories are obtainable from :—

- 1⅛ oz. white bread (2 small slices ½ in. thick).
- 1¼ oz. wholemeal bread (2 slightly smaller pieces).
- One-half of a doughnut.
- Half a small helping of fruit cake.
- 2 macaroons.
- Half a sponge cake.
- Loaf sugar, 6 cubes.
- Other sugar, 2 tablespoonfuls.
- One good helping of oatmeal porridge.
- One shredded wheat biscuit.
- 1 medium potato.
- ½ oz. of butter.
- ⅘ oz. cheese.
- Half a glass of milk.
- 1 banana.
- 3–4 dates.
- 1½ large dried figs.
- 1 large orange.
- 3–4 large plums.
- 4 medium prunes.
- Small serving of lean beef, leg of mutton, or veal.
- 1 mackerel.
- 3–6 sardines.
- 1 doz. oysters.

CHAPTER V

THE DAILY RATION

"Lord make my spirit good and gay—
Give me my daily bread."

"Plain and humble folk . . . instead of the number of calories want to know the number of tablespoonfuls."

THERE can be little doubt that when daily bread is deficient in quantity and quality, the human spirit is neither good nor gay. Count Rumford, the first person who realised the meaning of heat and energy, gave an illuminating piece of advice to the King of Bavaria when asked to deal with the swarm of criminal beggars of Munich: "Let us not try to make them happy because they are good; let us make them happy first and then good." No one can be good on an empty belly, because no one is happy.

Accepting this view, the question at once becomes "How much?" What are the requisite amounts of protein, fat, carbohydrate, salts, roughage, vitamins, water and energy which will keep the normal man in health, so that he may possess a sane mind in a healthy body? It will need some discussion to decide, even provisionally, what some of the rations should be, but it is not difficult to decide off-hand how much water and roughage are essential.

Water.—It is easy to take too little fluid; indeed, many people do so. Expecially is it easy in countries where the air is not laden with moisture—*e.g.*, Canada in winter—or where one is losing much water through perspiration (*e.g.*, the tropics). There is abroad a feeling against taking much fluid with meals; it is thought to weaken the power of digestion. For the normal person, as has been already stated, there is little harm done by diluting the digestive juices of the stomach and intestine; it is only to the person with a dilated stomach that fluid with meals becomes a danger.

The minimum ration of fluid per day is one and a half quarts. Two quarts is by no means excessive, for the daily output in the urine is nearly one and a half quarts, and, in addition to this, the body is losing water in the breath and the perspiration. Two quarts a day need rather assiduous drinking. Two breakfast cups at breakfast yield about one pint; one glass of water at lunch a half pint; two tea cups yield another half pint; and two glasses of water at dinner another pint. This adds up to three pints, or one and a half quarts. It is doubtful if many people consume more.

This does not apply to the United States and Canada, where, in the northern parts, the winter climate, apart from legislation, is unbelievably dry. There, in all offices, railway trains, and the more up-to-date universities, you see apparatus, often com-

plicated and very American, for supplying the staff with iced drinking water from " individual " drinking cups. The first thing you do at an American hotel is to ring for iced water. Without this continual drinking the body becomes desiccated and loses weight. If you have European habits of drinking only at meals, you lose weight during the Canadian winter, which weight you can regain by taking drinks between meals.

In more tropical climates the same is true. The danger is that so much water is lost in perspiration that the kidneys have less to draw upon for their normal work of excretion. The unwise stimulate them to activity with alcohol ; the wise with more water. Water, moreover, may help those with constipation.

Roughage.—The necessary ration depends on the individual. Some can stand, and need, large quantities ; others have much more irritable alimentary tracts. Sufficient roughage to promote one evacuation of the bowel per day is the ideal ration. Enthusiasts would like to make brown bread compulsorily the only bread sold in this country. This would be unpleasant to those persons who have an irritable bowel. Every one must be a law unto himself in the matter and find out what is his best dosage of roughage. The average man will find enough in one helping of cabbage, or salad, or an apple, or a large piece of brown bread per day. The

vegetarian need never worry about roughage ; it is the meat eater, with his white bread and potatoes, who is in danger of getting too little.

Salts.—As regards salts, we have already written above. With an all-round diet containing milk, eggs, cheese, meat and green vegetables, and conservative cooking of vegetables, there should be little danger of a deficit. Trouble is likely to arise only if the diet is restricted. Perhaps too much restaurant, hotel and institutional life cause their well-known dietary troubles, owing to the wastage of the salts in the kitchens of these places, but that is by no means settled.

The two main problems are the protein and the calorie ration per day, with subsidiary problems of the relation of protein, fats and carbohydrate and the ration of vitamins.

The Protein Ration.—There are a number of ways of attempting the solution of the problem of how much protein is needed per day. We may collect data from all over the world from classes of people among whom there is little restriction due to economy, and find how much protein they consume per day. This solution is based on the assumption that instinct is a good guide. It is, it may be argued, the collective wisdom of the ages as regards diet. The poorer classes are excluded, because possibly their poverty prevents their following their instinct ; and the

nouveaux riches must be excluded, because a possible want in the past has driven them to a vulgar excess. It is data from well-established classes which are requisite. Another method is to experiment over long periods upon oneself or upon volunteers and discover whether an amount lower or higher than the average is beneficial. Thus a man might proceed to cut down his protein intake to half what it normally is, live on this for six months or a year, and note the effects upon health and endurance. Subsidiary experiments may be made upon animals. This introduces an error in arguing from animals to man, but it cuts out another source of error, viz., the psychological factor. If you are living on an unusual diet, your interest in the experiment may carry you through a number of tasks which ordinarily will be shirked. The experimental psychologists are well aware of this danger. When testing the effects of a drug such as alcohol, opium, etc., on a human being's capacity for quick reaction, they must not let him know the nature of the drug, nor the quantities given, nor even the day upon which it is given. It must be disguised. To carry this method of experimentation into research on problems of diet would be difficult, though not impossible. So far it has not been done, and therefore such results as we have must be received with a certain misgiving and suspicion.

A third method is to discover the minimum wear

and tear of protein in the body, and then from this to calculate, by means of the biological value of the proteins of one's diet,[1] how much will just replace this wear and tear.[2]

This method gives a minimal amount only and makes several assumptions which may not be justified. For example, it assumes that the minimal wear and tear on the body proteins when the body is fasting from proteins, is the *optimal* or *best* wear and tear. It assumes that all above and beyond this minimal wear and tear is a luxury.[3]

The Statistical Enquiry.—Leaving on one side the theoretical method as being too speculative, there remain the two other methods. The first—the statistical enquiry—has given surprisingly consistent results. It is true that we see the influence of climate

[1] See pp. 64 *et seq.*

[2] We assume that the minimal wear and tear of protein is that protein lost to the body when it is on a protein fast. Large masses of starch, sugar, salts and roughage are given, but no protein. The nitrogen output (which is a measure of protein wear and tear) falls and falls—first swiftly, and then more gradually—till it is about 3 grams per day for a person weighing about 11 stone. Such a person is utilising, therefore, $3 \times 6{\cdot}25$ grams of his body protein per day, *i.e.*, $18{\cdot}75$ grams. From the biological value of the proteins given at food in an ordinary diet we can estimate how much of those proteins would be necessary. If their biological value is 50—*i.e.*, two parts of food protein replace one part of body protein, or, put in another way, the food protein is only 50 per cent. as good as body protein—then the food protein should be $2 \times 18{\cdot}75$ grams, or $37{\cdot}5$ grams per day.

[3] That this is unlikely is shown by the fact that when you drop from a normal protein intake to a zero protein intake, the output in the urine does not instantaneously fall to the minimal output. There

and class and nation upon them. But the divergence is amazingly small. Thus a Munich University professor takes 100 grams (3½ oz.) of protein per day; French Canadians, 109 grams; a labourer and his family in Edinburgh, 107·7; fourteen professional men in America, 104; Europeans in Java (professional men), 104; men in sixteen student clubs in America, 105; and, during the War, among the professional men at University College, London, 90 grams protein metabolised (=approximately 100 intake). Of course, if we take statistics from students belonging to strenuous athletic clubs or from working-class men doing heavy manual labour, or much out-of-door work, the figures are higher. The above figures were chosen because they come mainly from the professional classes, whose life is not strenuous—muscularly—and is indoors. We may take these as a standard from which to calculate all other dietaries—they are average sedentary men.

is a lag, and the minimum is only slowly reached. The same is true when the protein is suddenly increased in the diet from zero to the normal amount. The output lags behind the intake, as though the body were laying in stores of something essential to the body which had been depleted by the protein fast. (A similar argument was used as regards the intake of common salt.) Further, the biological values of the proteins are still an unknown quantity, especially in combination. Reliable figures for gelatin and wheat only are known; the biological value of milk proteins may be 51; the rest have, it is true, been given figures, but no trust can be put upon them. We shall assume that the figure 37·5 grams of proteins of biological value as good as those of milk is a starvation, minimal figure, and one to be approached in practice with caution.

Experimental Study.—This figure of 100 grams per day has been vigorously criticised by a number of physiologists (two in particular) as being too high. It had been known for long that a man might be kept without loss of protein (*i.e.*, in "nitrogenous equilibrium") on a diet of potatoes—6½ lb. per day!—containing not more than 54 grams of protein. In 1904 a long course of experiments showed that professional men, athletes and U.S.A. soldiers could be maintained without loss of protein for a period of some months on a daily intake of protein not more than 60 grams. The chief experimenter, in his own case, could cut it down considerably below 60. One and all claimed that they felt much "better" during their partial abstinence from protein, and won athletic contests, and were free from aches and pains which used to beset some of them before the experiment.

The work has been reinforced by observations made by a professor of physiology in Denmark upon himself, his family and his laboratory assistant. Nitrogenous equilibrium was obtained on a much smaller intake than the 100 grams per day which the normal man instinctively takes. It might be argued that as protein is relatively costly, and its digestion, assimilation and excretion throw work on the alimentary and excretory system, to take the amounts we normally do is wasteful and unphysiological. And yet the world, even of physiologists,

refuses to be converted by this work. While it is admitted that nitrogenous equilibrium can be maintained for months on a low protein intake it is not admitted that this is true for the whole of life. A bridge builder leaves a margin for safety; the excess of protein over the minimum may be the factor of safety to enable the body to meet the various contingencies of existence—disease, accident and so forth. Certain it is that the growth of young animals is largely influenced by the quantity of protein they get, and if they are kept back in growth by only a few days on a diet poor in protein it will take weeks for them to recover even on the best of dietaries. Clearly we cannot accept the low standard of protein for growing children. As regards adults, we must weigh the experience of the ages against the facts of experiments which last nine months only. This is by no means said to exalt instinct above experiment. Instinct has led to scurvy, beri-beri and rickets, and experiment may abolish these if instinct and stupidity will allow it. But, as far as can be seen at present, it is wise, while keeping a completely open mind, to adopt the larger figure—*i.e.*, 100 grams of protein—as the daily ration for the average sedentary man. We will trust instinct rather than the lower figures suggested by experiment (60 grams) or by theoretical calculation from the minimal protein wear and tear (37·5 grams when the food protein has a biological value of 50).

The next problem is of what nature shall the protein be? Shall it be animal, vegetable or a combination of the two? Clearly that matters. Some proteins are of first-class quality, others of much lower quality. In the theoretical calculation given above [1] we assumed that the proteins were milk proteins and had a biological value of 50. On such an assumption, 37·5 grams of protein would be needed. But it is fairly certain that milk proteins are very good biologically if not absolutely in the front rank. If 37·5 grams of A1 protein is necessary for the *minimum wear and tear* of protein, to ask that 30 grams be of A1 protein and the remainder of the total (70) be of lower class is certainly not to ask too much. Such is the general consensus of researchers on dietetics: out of the 100 grams protein to be taken per day, 30 should be A1 (*i.e.*, animal proteins) while the rest may be lower grade (*i.e.*, vegetable) proteins.

Practical Problems of the Protein Ration.—While this gets us, theoretically, considerably farther forward, practically it does not help much. It is difficult enough to visualise 30 grams ($1\frac{1}{14}$ oz.) of protein as such, but to visualise it in the form of milk, fish, meat, eggs or bacon is a still more difficult feat. Of course it may be easily calculated from the tables.

[1] See p. 126, footnote.

The problem reads: Fresh herrings (let us say) are required to yield me 30 grams protein; how much shall I buy? The tables tell us that 100 grams of herrings contain 14·6 grams protein.

14·6 grams protein are found in 100 grams of herrings.

$\therefore$ 1 gram " " $\frac{100}{14{\cdot}6}$ " "

$\therefore$ 30 grams " " $\frac{100 \times 30}{14{\cdot}6}$ grams.

In England this does not help much, for we do not yet, unfortunately, buy by kilograms and grams, but in ounces. One ounce weighs the same as 28·4 grams. Applying this: $\frac{100 \times 30}{14{\cdot}6}$ grams $= \frac{100 \times 30}{14{\cdot}6 \times 28{\cdot}4}$ oz. $= 7\frac{1}{4}$ oz. approximately. And figures for other foods may be as easily calculated. The rule is multiply the percentage by the number of grams in an ounce and divide the result into the amount of grams wanted (30) multiplied by 100; or, more easily still, divide the percentage of protein given in the tables into 105·7 $\left(\text{which is } \frac{100 \times 30}{28{\cdot}4}\right)$.

To save the reader even this expenditure of time and energy, the following figures are given :—

Minimum Protein Ration in Terms of Foods.—The minimum ration of A1 protein (*i.e.*, 30 grams, or $1\frac{1}{14}$ oz.) is found in :—

$4\frac{1}{4}$ oz. cheese.
$5\frac{1}{4}$,, smoked herrings.
$5\frac{1}{2}$,, lean beef.
7 ,, lamb.
$7\frac{1}{4}$,, fresh herrings.
$7\frac{1}{2}$,, mutton.
$7\frac{1}{2}$,, ham (lean).
8 oz. pork.
4–$4\frac{1}{2}$ (*i.e.*, 9 oz.) eggs.
10 oz. cod.
11 ,, mackerel.
12 ,, fat bacon.
1·65 pints of milk.

If you take any one ration of these you have eaten sufficient animal protein for the day. It is, of course, unlikely that you will rely on one and one only of these per day for the ration. Thus it may be made up of half a pint of milk and 2 oz. of bacon at breakfast (= ½ ration), two servings [1] of beef, mutton or ham and 2 cubic inches of cheese divided between the two other important meals of the day. By thinking in terms of the above amounts in the table, it is not difficult to know whether or not you are getting the daily animal protein ration.

Another way of treating the problem is to estimate the amounts of the various foods used as sources of animal proteins per day or per week in the family and divide by the number of people in the household who are consuming it. All children over fourteen may be counted as adult, those from two years to six years counted as half adults, from six to ten as six-tenths of an adult, and from ten to fourteen as 0·83 of an adult. Women are to be counted also as 0·83 of an adult. Perhaps the last statement will evoke astonishment and chagrin among those who claim equality of suffrage for women with men. It may, however, soothe them to learn that males are by nature more wasteful of protein than females, and that the latter turn their ration of protein to more

[1] As the "helping" of meats varies in different households, it must be explained that by a standard helping we mean about 3 oz., *i.e.*, two slices a quarter of an inch thick and about 12 square inches in area (*i.e.*, 6 × 2 inches, or 4 × 3 inches).

account than the males. Experiments on animals show that females grow better than males on a diet poor in protein, and this fits in well with observations made upon working-class diets. On ordinary diets the man is the heavier and more robust of the two; while on poor diets the reverse is often the case. Apparently nature in this respect is kinder to women; they can mature better on poor diets than men. The same is true as regards the energy obtainable from foods, as we shall proceed to show.

The Energy Ration.—Food is, as we have seen, the source of bodily energy. It almost follows from first principles that there must be a definite ration of calories requisite per day per adult male in sedentary occupation. Investigations which have been in progress for many years have shown this to be so. There is almost unanimous agreement that the average man needs an amount of food per day which will yield 3,000 great calories. This is the amount instinctively taken when there are no restrictions due to economy, nor climatic surroundings which would induce an over or under production of energy.

Climate and Energy.—Thus professional men in many different parts of the civilised world take food which yields 3,000 calories, as long as the climate is

temperate. Statistics from Germany, France and England agree on this figure or somewhat above. Only where the climate is more rigorous or more tropical, or the people investigated are impoverished, is there much departure from this figure. Thus, professional men in Malay or Java may take a diet which yields 2,500 great calories only; those in Finland one which yields as much as 4,000 great calories, while on an Antarctic expedition the calorie value of the food supplied will have to be as high as 7,000.

This result of climate may account for the one serious discrepancy, *i.e.*, that between what the European physiologist demands in calorie value per average adult male and what the American postulates as necessary. The Food (War) Committee of the Royal Society adopted a figure a little above 3,000 great calories for the average man, whereas the figure nowadays put forward in America is 2,500. But it must be remembered that in summer the temperature of the whole of North America exceeds that of the British Isles, while in winter the average American attempts (and, being what he is, usually succeeds in) keeping his house and his office to summer heat.

Variation with Physical Work.—It is reasonable, then, to accept the figure 3,000 as the measure for the average man of his need for calorie value, and to

discuss how this varies with occupation, size and age, and if sex affects the calorie requirements. Looking through the tables of calculated values of the diets of various men, athletes, manual labourers, etc., it is clear that the occupation makes a great deal of difference. If the man takes violent continued exercise (*e.g.*, rowing, long-distance running), or his work is heavy (*e.g.*, coal-mining, woodcutting), or is out-of-door work, his calorie intake is greater. This was to be expected from theoretical considerations. All bodily energy comes ultimately from food. Therefore, if we increase our output of work, more food must be consumed to meet the increased demand. Further, in cold weather or in cold climates more heat is lost from the body. As the food is ultimately the source of all bodily heat—it is our fuel—a great heat loss impels a greater consumption of food. Thus we find the average diet of seven university boat crews worked out as capable of yielding over 4,000 great calories. Blacksmiths take food to yield 4,000 calories; stone masons, 4,300, and sawyers 4,900. Backwoodsmen may demand a still higher intake, and the record yet was seen in a twenty-four-hours bicycle race in which one competitor took food that yielded 9,000 great calories, and even then lost weight. It is suggested that his output was 10,000 calories. Mental work, on the other hand, appears to demand no extra intake of food, so that if justice were to be done—from the

food standpoint, rather than from the creative standpoint—the dock labourer should earn more than the Prime Minister !

At present we can make a rough scale of different employments and the calorie intake necessary for each grade. Sedentary occupation—*i.e.*, that of most professional men, including a certain amount of standing, say, in the Stock Exchange, working in a laboratory or office—we may take as a basis or standard and call the index 1, meaning thereby that such a worker needs 3,000 × 1 great calories.

Light manual work indoors—painting, cabinet-making, etc.—demands a higher index, say 1·2. This means that a painter needs 3,000 × 1·2 great calories per day. Moderate work indoors, or light work out of doors, has an index 1·25. Moderately heavy work indoors, or moderate out-of-door work, should have an index 1·33. Heavy indoor work (or below ground) or moderately heavy out-of-door work counts as 1·50 times the normal. Very heavy work may need an index of 1·75.

Thus, carpentry indoors or painting out of doors counts 1·25 ; furniture-moving, warehousing, gardening, 1·33 ; while coal-mining, stone-cutting, dock-labouring and sawyers' work, 1·50.

Sex and Energy Ration.—Women apparently need less than a man. All estimates agree in showing that a woman's index is about 0·83. This surprising

result is borne out in experimental work. The male takes more and better food to achieve the strength and stature which is his by nature. There is some fundamental difference between the male and the female which has given rise to the generalisation that the male is katabolic (*i.e.*, destructive of material), while the female is anabolic (creative, or capable of building up material).[1] The generalisation is but half true, for the male has to build up the material of the body from food just as the female does ; but on the whole it takes more to create and recreate his frame than it does the female's. He expends energy on a higher level than the female ; she expends it more conservatively.

The Energy Ration for Children.—The problem of the index for children is much more difficult to solve. It is easy to collect statistics of the rate of basal metabolism (that is, the rate at which the body gives out calories during rest in bed), and it has been done in America on a truly American scale. We know, for instance, that the rate of production of calories per square metre of surface rises rapidly from the moment of birth to a peak of about 60 calories per square metre per hour at the age of six, to sink from that peak to a level of about 40 at ten. During the adolescent period there is a moderate increase, and

[1] Few men would agree with this generalisation where money is concerned.

thereafter a very slow fall, which continues until old age.

Basal metabolism is, however, merely an index of the *minimal* wastage of heat during rest. Obviously much more must be given when the child is active, and the amount should depend on the activity. Till there are collected statistics of the calorie intake of children at all ages made by reliable observers, we must make a guess at the index.

Figures used by the Royal Society's Food (War) Committee are :—

For children from birth to six years of age the index is	0·5	(*i.e.*, 1,500 great calories).
For children from six to ten years of age the index is.	0·6	(*i.e.*, 1,800 „).
For children from ten to fourteen years of age the index is . . .	0·7	(*i.e.*, 2,100 „).
For girls after fourteen years of age the index is.	0·83	(*i.e.*, 2,490 „).
For boys after fourteen years of age the index is.	1·0	(*i.e.*, 3,000 „).

Frankly, these figures are provisional only. They are open to a number of doubts and criticisms. For instance, the index 0·5 for a nursing child is undoubtedly too high. The calorie intake of even a large baby hardly touches 750 great calories—an index of 0·25. While at the older end of the scale it may be argued that 1,500 great calories is not enough for an active child of six. What statistics we have show that an active child at the age of six consumes

more than 1,500 great calories. In the writer's own experience, a child of two and a half years, weighing 35 lb., who is active and much in the open air, and not so heavily clad as is the custom in this country, takes 1,800 great calories per day. Further, a plea has recently been made that we should give an adolescent considerably more even than an adult. Investigations carried out in a well-to-do boarding school showed that, neglecting the intake from the "tuck" shop (!), the boys were consuming over 4,000 great calories per day. The figures taken as a standard by the Committee of the Royal Society do not err on the side of generosity, but they will do for the present. Using them as a basis, and calculating from them the requisite calorie value of the food of working-class families investigated by the Household Work Department of King's College for Women (Household and Social Science Department), it was seen that the actual intakes agreed closely with the theoretical. The Committee's figures apparently are confirmed by actual observations on working-class folk. They must be taken as minimal figures.

Family Energy Budget.—Accepting them as a basis, how are we to know if a certain family is obtaining its quota of calories? It is not difficult, but it involves much tedious arithmetic. The way to proceed is as follows: [1] At such and such a date all

[1] A simpler method is given on p. 144.

the foodstuffs in the larder and store-room must be estimated. There will be so much sugar, so much flour, butter, tapioca, etc. Then for a period of a week all the incoming food must be added to this. At the end of the week the total amount still present in the pantry and store-room must be re-estimated. Subtract this new total from the original stock-taking, add the incoming food for the week, and we get the total consumption of food for the week. Then we proceed from the tables of the calorie values of foods to find how many calories the foods consumed represent. Each pound of butter represents 3,410 great calories and each pound of sugar 1,790 great calories. Totalling all, we thus reach the figure for the calorie intake per week for the given family.

The caloric needs of the family may be calculated as follows: Assuming the father to be a clergyman, his index will be 1·0; his wife's 0·83; the children, whom we will assume to be nine, twelve and fourteen years of age, the last being a boy, will need indices of 0·6, 0·7 and 1·0. Assuming there to be two maids, each will have an index of 0·83. The total index will be 1·0 + 0·83 + 0·6 + 0·7 + 1·0 + 0·83 + 0·83, or 5·79, *i.e.*, the family counts as 5·79 adult males. The total calorie need per day will be 3,000 × 5·79 or 17,370, or per week, 121,590. The amount supplied in the food taken during the week should cover this weekly need; if it does not, trouble will probably be brewing somewhere.

			Protein.	Fat.	Carbo-hydrates.	Calories.
		Pounds.	Grams.	Grams.	Grams.	
Milk	3 pints per day	1·750 per day	25·38	30·10	39·6	542
Bread	4½ 4-lb. loaves per week	2·500 „	80·60	13·60	553·0	2,984
Butter	1¼ lb. per week	0·178 „	0·80	65·30	—	607
Meat	2 lb. per day	2·000 „	171·20	62·50	—	1,350
Sugar	3½ lb. per week	0·500 „	0·00	0·00	226·8	895
Bacon	½ lb. per day	0·500 „	20·00	133·80	—	1,360
Oatmeal	2 lb. per 12 days	0·167 „	9·70	4·80	47·3	287
Potatoes	2 lb. per day	2·000 „	11·60	0·80	128·8	590
Tea	½ lb. per week	0·071 „	—	—	—	—
Cocoa	¼ lb. per week	0·036 „	3·30	4·90	7·30	88
Flour	7 lb. per 10 days	0·700 „	35·30	4·10	252·0	1,181
Suet	½ lb. per week	0·071 „	0·40	30·30	—	278
Cheese	½ lb. per week	0·071 „	8·20	11·10	1·0	141
Jam	3 lb. per week	0·418 „	0·00	—	129·0	532
Vegetables	1½ lb. per day	1·500 „	18·40	2·40	41·5	264
Margarine	½ lb. per week	0·071 „	—	27·30	—	250
Lard	1 lb. per week	0·142 „	—	64·80	—	590
Condiments	—	—	—	—	—	—
Total	—	—	384·88	455·80	1,427·3	11,939
Total per adult male	—	—	110	130	408	3,410

Professional Man's Food Budget.—A budget of a small family in the professional classes with simple wants is given on p. 141. It consisted of man, wife and two domestics, and can, therefore, count as 3·5 adult males.

This family easily was obtaining the minimal ration, but may be criticised as on p. 162.

Another budget, this time of a working-class family, which was badly mismanaging things, is given. (It may be said that, in the experience of Miss Hyde, of King's College for Women, mismanagement of the family food budget was a rare thing, in spite of the fact that practically every circumstance—housing, heating, cooking appliances, and knowledge of protein and calorie values (!)—is adverse to it. Of course valuable advice could be given to the working-class woman from the professional chair of how to spend money to greater advantage, but she at least makes as good a show as her betters.)

A Working-class Food Budget.

FOOD BUDGET OF A WORKING-CLASS FAMILY, FEBRUARY, 1921.

Total in family : man (labourer = 1·25), wife, and four children aged eleven, nine, five years and nine months respectively. These equal 4·38 adult males.

Total calories needed per day : 13,140, or per week, 91,980.

	Food.	Protein. oz.	Calories.
4 lb. 9 oz.	Shank of beef . .	13·20	5,554·6
6 oz.	Suet . . .	0·25	1,327·5
1 lb. 9 oz.	Beef pieces . .	3·80	1,281·2
24 lb.	Bread . . .	31·80	29,033·0
2 qts.	Milk . . .	2·60	1,512·0
16 oz.	Condensed milk .	1·40	1,520·0
8 lb.	Potatoes . . .	2·30	2,480·0
1½ lb.	Onions . . .	0·30	307·5
½ lb.	Margarine . .	—	1,788·0
½ lb.	Lard . . .	—	2,005·0
¼ lb.	Butter . . .	—	860·6
½ lb.	Bloaters . . .	1·04	341·4
2½ lb.	Herrings . .	5·80	1,608·0
¼ lb.	Tea . . .	—	—
2 lb.	Sugar . . .	—	3,644·8
¼ lb.	Cocoa . . .	0·70	553·6
1¾ lb.	Flour . . .	3·10	2,924·9
½ lb.	Barley . . .	0·80	763·0
2 lb.	Oatmeal . . .	3·90	3,750·0

Totals :

Per week—

Animal protein .	28·09	
Vegetable protein .	42·90	
Total . .	70·99 oz.	Calories 61,255
Per day . .	10·14 oz.	8,751
Per adult male per day	2·32 oz. (or 65·7 grams).	1,998

It is the last line of this budget which is significant. Instead of the 100 grams ($3\frac{1}{2}$ oz.) of protein, only 65·7 grams ($2\frac{1}{3}$ oz.) are being obtained, of which only 26 grams is animal protein (against a minimum of 30 grams). Instead of the requisite 3,000 great calories per day, only 1,998 are being taken. This summary of the results is tragic. Someone (prob ably the wife) or everyone in the family is being woefully underfed. There is a 33 per cent. deficit in both protein and calories. Such a budget spells disaffection and disease.

Estimation of Energy Value of Menu.—A simpler though rougher way in which to estimate the calorie value of a day's food is to measure it in 100-calorie portions. If we have visualised a number of 100-calorie portions (see the brief list on p. 120), we can rapidly estimate the calorie value of any meal. For example, take a breakfast consisting of three pieces of toast (150 calories), a piece of butter the size of a walnut (100 calories), 2 oz. of bacon with the fat (300 calories), two breakfast cups of coffee made with half milk (200 calories), three lumps of sugar (50 calories) and a small amount of marmalade (50 calories), we get a total of 850 calories.

Lunch and dinner can be calculated in a similar way, and if each totals as much as breakfast (which is probable), there is left only 450 calories to b supplied by tea. Two slices of bread and butter,

four biscuits weighing half an ounce each, and the milk and sugar in the tea will cover this amount.

Probably this method of estimation will be more serviceable in the ordinary household than the stock taking method, which is more applicable to an institution such as a college or school. Either way, there is some work to be done by the person in charge ; much arithmetic or much weighing out of standard portions and visualising them. Nothing worth having can be had without effort. The engineer thinks calorie values worth while in feeding his machines. The attitude of the competent householder to the human engines to be supplied with fuel should be (among many other things), that of the engineer.

Distribution of Calories between Protein, Fat and Carbohydrate.—So far we have dealt only with the protein and the calorie intake, and have neglected the fat and carbohydrate intake. Now, the main sources of calories in the food are the fats and carbohydrates. From the 100 grams ($3\frac{1}{2}$ oz.) of protein consumed per day, only 410 great calories are obtained, leaving a balance of 2,590 to be obtained from other sources. Taste and the purse are what decide the proportion between fats and carbohydrates in supplying this deficit. Fats are dear as compared with carbohydrates ; so it is natural that the poorer classes should take more carbohydrates

in proportion to fats. As was stated (pp. 68—71) above, not all the deficit can be made up from fats and apparently not from carbohydrates. If a large amount of fat is taken, " biliousness " results and we get a ketosis ; if the fats are cut out of the diet there arises a craving for them. Statistics show that, in the diet of those able to afford fats, about 100 grams ($3\frac{1}{2}$ oz.) are taken per day, against about 400 grams (14 oz.) of carbohydrate ; while in the working classes but 50 grams of fat ($1\frac{3}{4}$ oz.) are taken, as against 500 grams ($17\frac{1}{2}$ oz.) of carbohydrate. The calorie values of these diets work out to 2,980 and 2,925 respectively, thus :—

	Great calories.		Great calories.
100 grams of protein yield . . .	410	100 grams of protein yield . . .	410
100 grams of fat yield	930	50 grams of fat yield	465
400 grams of carbohydrate yield .	1640	500 grams of carbohydrate yield.	2,050
	2,980		2,925

These are sufficiently close to the 3,000 great calories to be accepted as an adequate diet. In any such stocktaking as was instanced above, the distribution of the calories between protein, fat and carbohydrate should also be estimated. Any results which yield the requisite number of calories and falling anywhere between the limits given immediately above may be considered satisfactory. Often

in investigating the budgets of the poor it will be discovered that they are taking per adult male more than 100 grams of protein. No one should condemn them as wasteful for this, unless the animal protein intake is high. The poorer classes' main source of calories is bread. As bread contains about 8 per cent. protein, anyone who buys it for its cheapness as a source of calories is forced, willy nilly, to consume much protein also. The protein intake of those who live on cereal foods is often higher than might be expected.

The Daily Vitamin Ration.—One thing only remains to be considered while we are on the topic of the daily ration, and that is the vitamins. What should be the daily ration of vitamins A, B and C ? Here we can give guesses only. The author's guesses are as follows : vitamin A, $\frac{1}{2}$ oz. of butter or half a pint of milk per day ; vitamin B, an orange, onion or tomato per day. (Possibly white bread, and certainly brown bread, in default of any other source would do. If in doubt, take a little Marmite.) Vitamin C, an orange, tomato, or 4 oz. of cabbage, not over-boiled, per day. For children, 1 teaspoonful of a 50 per cent. cod liver oil emulsion and the juice of half an orange or tomato has been found to be enough. The minimal quantities no one has yet estimated—it is a subject in which no one cares to experiment.

Summary.—There are for each requisite in a diet minimal quantities below which it is unsafe to go. While these have not been exactly estimated for every requisite, we have figures which may serve as guides for every normal person. These are for water, two quarts daily; for roughage, sufficient to provoke a daily evacuation of the large bowel—each must find his own threshold; for salts, sufficient is probably obtained if milk, and green vegetables form a good part of the dietary; for protein, 30 grams ($1\frac{1}{14}$ oz.) animal protein and 70 grams vegetable protein—the amounts of different foods which will yield the animalprotein ration are given on p. 132—for fats 100 grams ($3\frac{1}{2}$ oz.), for carbohydrates (17 oz.) and for calories, 3,000 for the adult male. The amounts vary with occupation, age and sex, and the indices for these varieties are given on p. 136. Minima for vitamins are not known, but as long as we base a diet on milk, eggs, cheese, butter, fresh fruit and vegetables, there is likely to be no deficit of them.

CHAPTER VI

SCIENTIFIC ECONOMY IN FOOD

"Wherefore do ye spend money for that which is not bread? and your labour for that which satisfieth not?"

BUYING Energy.—As we have already said, the engineer will investigate the heating power of the fuel he intends to burn and choose the fuel which gives him the largest heating power with the smallest outlay of cash.

The modern householder, too, who wishes to run the heating of a house economically will compare the cost per unit of heat evolved and available for warming a room, heating the bath water, or for cooking, when coal, coke, gas or electric power are employed. From information given me by my colleague, Professor C. K. Tinkler, I learn that for heating a dining-room, electric power at $2\frac{1}{2}d.$ per unit is nearly six times as expensive as gas at 4*s.* per 1,000 cubic feet, or 9·6*d.* per therm; that a gas fire for occasional use is cheaper than a coal fire, while for prolonged use the coal fire is cheaper than gas, besides being more pleasant; and that gas cooking with a separate coke hot-water installation is as economical as the kitchen range which com-

bines the functions of cooking and heating the bath water.

The question arises, cannot the purchasers of foods do the same as regards their capacity for supplying proteins, calories, vitamins, etc. ? The present time is naturally one when this question is pressing, for to-day most people are " naturally subject to a kind of disease . . . called lack of money." We all want to get the best value for our money, and there is a possibility that in purchasing foods we are spending money for that which is not bread and for that which satisfieth not. In the sequel it will be seen that the value of a foodstuff is not proportionate to its price. The best foods are not the most costly.

Cost of the Protein Ration.—The simplest way to tackle the problem is to work out the cost of the daily ration of the more important requisites of diet. These are clearly animal proteins and calories. We have decided to demand 30 grams ($1\frac{1}{14}$ oz.) of animal protein for each adult male per day. We have also seen that this is supplied by $4\frac{1}{4}$ oz. cheddar cheese, $5\frac{1}{4}$ oz. smoked herrings, $5\frac{1}{2}$ oz. lean beef, 7 oz. lamb, $7\frac{1}{4}$ oz. fresh herrings, $7\frac{1}{2}$ oz. mutton, $7\frac{1}{2}$ oz. lean ham, 8 oz. pork, 9 oz. (4 to $4\frac{1}{2}$) eggs, 10 oz. cod, 11 oz. mackerel, 12 oz. fat bacon and 1·65 pints of milk. On November 15th, 1924, the market prices [1] of these were : cheese, 1*s.* 4*d.* lb., kippers, 10*d.* lb. ; beef,

[1] From the Army and Navy Co-operative Stores Price List.

1*s.* 6*d.* to 2*s.* lb.; lamb, 1*s.* 6*d.* lb.; fresh herrings, 6*d.* lb.; mutton, 1*s.* 6*d.* lb.; ham, 2*s.* lb.; pork, 1*s.* 6*d.* lb.; eggs, 3*d.* to 4*d.* each; cod, 9*d.* lb.; mackerel, 7*d.* lb.; bacon, 2*s.* lb.; and milk, 7*d.* quart. Calculating the cost of the daily ration of protein, we find that the foods range themselves in an entirely different order. The following gives them in their new order :—

Fresh herrings head the list at $2\frac{3}{4}d.$ per animal protein ration. A close second is smoked herring at $3\frac{1}{4}d.$ Cheddar cheese is next at $4\frac{1}{4}d.$ (New Zealand cheese, at 1*s.* lb., would cost only $3\frac{1}{4}d.$, and tie with smoked herrings.) Mackerel costs $4\frac{1}{2}d.$; cod and milk, $5\frac{1}{2}d.$ each; lean beef, $6\frac{1}{4}d.$; lamb, pork and mutton run close together at 8*d.*, $8\frac{1}{2}d.$ and 9*d.* respectively; and, somewhat later, ham at $11\frac{1}{4}d.$ Eggs, as a source of animal protein, cost 1*s.* to 1*s.* 4*d.* per ration, and bacon brings up the rear with 1*s.* 6*d.* It is an extraordinary range of price per calorie ration, from $2\frac{3}{4}d.$ to 1*s.* 6*d.*, and probably all equally good. Striking, of course, are the positions of herrings and cheese in the vanguard, but not unexpectedly so. Milk, however, is well to the fore, though, for some reason or other, unknown to the writer, people are inclined to economise in milk. (Of course, it is fortunate that people do not demand their animal protein in the form of milk, for the average consumption in England per head is $\frac{1}{4}$ pint, against the 1·65 pints needed.) Eggs almost win

the wooden spoon, but it must be admitted that their price is high at this season. In the spring the cost of a protein ration obtained from eggs would be 8*d*.—approximately that for lamb, mutton and pork.

The frugal Scot has for long realised the relative costs of the protein ration ; doubtless the discovery was empirical and not *viâ* the theoretical road. The Highlander, with his diet of milk, cheese and oatcake, and the poor university student, with his barrel of herrings, are witnesses to the economy and efficacy of those foods.

Cost of the Calorie Ration.—When we turn to foods as sources of energy, the range of cost which is presented to our choice is much greater than the range of cost per ration of animal protein. The latter, for the average foods, runs from one price to another five times as great. In calorie costs the range may easily be from one price to another twenty times as great without going outside the foods which any average housekeeper willingly admits to the menu. As we shall see, if we go outside the range of ordinary foods, we may come across even wilder extremes. People who have the money, and those who imitate them, are willing to spend extravagant amounts for flavour and texture, and while flavour and texture are by no means to be despised, as will be shown in a later chapter (VII.), too great a price

may be paid for them. A healthy appetite needs no tickling of the palate.

In a table which has been relegated to the Appendix, a large array of foodstuffs is given with their compositions and cost per pound. From these the cost per 1,000 great calories and the cost per protein ration are calculated. It is to be noted that the cost per pound varies greatly according to the time of year and the market. But by comparing the price at which they can be purchased with those given in the table, an adjustment can be made, so that the actual cost per 1,000 great calories can be ascertained. Thus eggs vary in price from 2*s.* doz. to 4*s.* doz. during the year. The price of 1,000 great calories obtained from eggs is 4*s.* 4*d.* in November. When the price of eggs falls to 2*s.* doz., or half the November price, the cost per thousand great calories also falls to one half, viz., 2*s.* 2*d.*

For our present purposes it is sufficient to call attention to the foods which appear out of the order in which popular prejudice puts them. This is done in the summary, which appears immediately below, of the costs of 1,000 calories of various common foods :

Summary of Costs of 1,000 *Calories.*

Below 2*d.* Haricot beans, 1¼*d.* White flour and oatmeal, 1½d.

2*d.*–4*d.* White bread, 2*d.* (Veg.) margarine, 2¼*d.* Germ bread, wholemeal bread, maca-

roni, spaghetti, rice and dried peas, $2\frac{1}{2}d.$ Sago and sugar, $2\frac{3}{4}d.$ Dates, $3\frac{1}{4}d.$ (Animal fat) margarine, tapioca, $3\frac{1}{2}d.$

$4d.$–$6d.$ Dried CURRANTS and figs, $4\frac{1}{2}d.$ POTATOES, $5d.$ Suet, treacle, $5\frac{1}{4}d.$ Neck of mutton (imp.), $5\frac{3}{4}d.$

$6d.$–$8d.$ Cornflour, $6\frac{1}{4}d.$ Parsnips, $6\frac{1}{2}d.$ BUTTER, raisins, $7d.$ Loin of lamb (imp.), $7\frac{1}{4}d.$; loin of mutton (imp.), onions, $7\frac{3}{4}d.$

$8d.$–$10d.$ Shoulder of lamb (imp.), $8d.$ Plain biscuits, $8\frac{1}{2}d.$ Ribs of beef (imp.), MILK, $9d.$ FRESH HERRINGS, $9\frac{1}{4}d.$ CHEESE, $9\frac{1}{2}d.$

$10d.$–$1s.$ Sweet biscuits, leg of pork, $10\frac{1}{2}d.$ Shoulder of mutton (imp.), smoked BACON, $11d.$ Leg of mutton (imp.), $11\frac{3}{4}d.$

$1s.$–$1s.\ 6d.$ Leg of lamb (imp.), $1s.\ 0\frac{1}{4}d.$ Neck of mutton (Eng.), turnips, $1s.\ 0\frac{1}{2}d.$ Kippers, loin of mutton (Eng.), $1s.\ 0\frac{3}{4}d.$ Carrots, fat round of beef (imp.), $1s.\ 1d.$ Loin of lamb (Eng.), $1s.\ 2d.$ Loin of pork and shoulder of lamb (Eng.), $1s.\ 2\frac{1}{2}d.$ Bloater, $1s.\ 3d.$ Ribs of beef (Eng.), $1s.\ 4d.$

$1s.\ 6d.$–$2s.$ Smoked ham, $1s.\ 6\frac{1}{4}d.$ Beet, $1s.\ 6\frac{3}{4}d.$ Lean round of beef (imp.), $1s.\ 7\frac{1}{2}d.$ Fat round of beef (Eng.), leg of

mutton (Eng.), shoulder of mutton (Eng.), 1*s.* 8*d.* Leg of lamb (Eng.), 1*s.* 9*d.* CONDENSED MILK 1*s.* 10½*d.* Oranges, 1*s.* 11¼*d.*

2*s.*–3*s.* Apples, 2*s.* 1¾*d.* Cabbage, 2*s.* 2¼*d.* Medium round of beef (Eng.), fresh haddock, 2*s.* 2¾*d.* Lemons, 2*s.* 4*d.* Lean round of beef (Eng.), 2*s.* 4¼*d.* Cauliflower, 2*s.* 6*d.* Bananas, 2*s.* 9*d.*

Above 3s. Grapes, 3*s.* 4*d.* COD STEAK, 3*s.* 7*d.* Celery, smoked haddock, 3*s.* 10*d.* EGGS, 4*s.* 4*d.* Spinach, 5*s.* COD (whole), 5*s.* 2*d.* Tomatoes, 6*s.* 8*d.* Sole, 6*s.* 10*d.* Cucumbers, 7*s.* 8¼*d.* TURBOT, 8*s.* 11*d.* HALIBUT, 9*s.* 0½*d.* Asparagus, 26*s.* 4*d.*

Pulse and Corn.—Glancing through this table, we note that the cereal and dried pulses are cheap as sources of calories. This was to be expected. We note, further, that vegetables, with the exception of potatoes at 5*d.*, parsnips at 6½*d.*, and onions at 7¾*d.*, are expensive as sources of energy. The truth is, we take vegetables for their salts, roughage and vitamins, not for their calories.

The Poverty of Fish.—On the whole, fish are very expensive as a means of purchasing calories, the only exceptions being the cheaper oily fish, herrings,

kippers and bloaters. The fact is, fish are poor sources of everything except protein, and ought really, to be banished from the poor man's table. When we see that cod costs over 3*s.* per 1,000 great calories, while the best English ribs of beef can be had at 1*s.* 4*d.*, the claim that cod is cheap becomes a myth. Sundry philanthropists, some of them with fish to sell, have been trying to persuade the public that fish is a better food than meat. As far as calorie value goes the story is not true. Even the cheapest fish hardly hold their own with the meats.

The Efficiency of the Cow.—On the other hand, milk at 9*d.*, butter at 7*d.* and cheese at 9½*d.* make a very good show. The prices chosen are winter prices. That for cheese (1*s.* 6*d.* lb.) is on the dear side. New Zealand cheese can be had for 1*s.* lb., which reduces the cost of 1,000 great calories to 6½*d.* So that, on the whole, dairy products are really inexpensive. None the less, it is upon these that the housewife often chooses to economise. The milk bill is a bill to be groaned over, while the butcher's bill, three times as large, is submitted to cheerfully. Instead of campaigns conducted by interested folk to beg us to eat more eggs, fruit and brown bread, we need a campaign on the part of the Ministry of Health begging us to drink (or eat) more milk. This for years has been the slogan of the authorities on foods in the United States, with the result that the milk con-

sumption is treble what it is in this country. At Wembley the comparison between our consumption and that of other countries was brought home to people by demonstration of the actual amounts consumed per head. Great Britain takes less than almost any other great country. Yet the dietitians say that the dairy-fed nations are the progressive nations of the earth !

Bacon, too, is a food upon which the middle-class housewife tends to economise. From the calorie point of view this is absurd. The cost per 1,000 great calories given was based on a price of 2*s*. 6*d*. lb. for bacon. This is absolutely the top price. Good Danish best middle back can be had at 2*s*. 2*d*., and the streaky at much less (1*s*. 8*d*.). These figures would bring the cost per 1,000 great calories down to 9½*d*. and 7½*d*. respectively. So that bacon should not be accounted a dear food. Yet in how many households do you not find fish for breakfast (at 3*s*. per 1,000 great calories), or eggs (at 4*s*. 4*d*.) ?

The Egg Exploded.—Eggs are another puzzle of the scientific purchaser of foods. True, the egg is convenient. It is easy to cook—so easy that most cooks cannot do it. As a food the egg is admirable. It is a source of two vitamins (A and B) and its yolk is good for first-class proteins. No doubt it is valuable in cooking in the quality and texture it imparts to foods. But, taking it all round, is the egg worth

while ? Vitamins A and B can be obtained more cheaply. Animal protein also more cheaply. And calories ? At less than a fifth of the price in milk ! Even when the egg glut is on, and one hardly dares to eat an egg for fear there won't be enough to put down in water-glass, they cost three times as much per 1,000 great calories as milk. Eggs, however, are a superstition, perhaps as a result of primitive religion, when they were a symbol of the rejuvenation of the earth. They are popularly supposed to be each equivalent to half a pound of beef steak. Here is the comparison :—

Half a pound of beef steak contains 34·5 grams protein, 42·2 grams fat, some vitamins A, B and C, and yields 532 great calories.

An egg contains 6·3 grams protein, 5·7 grams fat, vitamins A and B, and yields 82·5 great calories ; or less than one-fifth the protein, one-seventh the fat and one-sixth the calories !

Let us put it another way. Eggs are a favourite breakfast food. Even the average man does not consider himself badly treated if two boiled eggs are given him for breakfast. At the present cost of eggs, this means an expenditure of 8*d*. Let us see what 8*d*. will purchase if laid out upon other foods.

Eightpence will buy :—

		Grams, protein.	Grams, fat.	Great calories.
12 oz. kippers . .	yielding	48·0	37·8	548
1 lb. 5 oz. fresh herrings	,,	82·0	52·3	844

		Grams, protein.	Grams, fat.	Great calories.
9 oz. cod . . .	yielding	21·4	0·5	93
1 quart milk . .	,,	37·4	45·4	816
5 oz. beef steak . .	,,	21·6	26·4	333
6 oz. sole . . .	,,	22·8	2·3	129
5 oz. bacon . .	,,	13·5	84·3	838
2 eggs . . .	,,	13·3	10·3	157

It is obvious at once that eggs are dearer than any other food given for proteins; dearer than herrings (fresh or kippered), milk, beefsteak and bacon for fat; and dearer than all except cod and sole for calories. In fact, eggs and white fish are food for millionaires only. The value of the egg as food is exploded. Milk, however, makes a fine showing, especially as, in addition to its protein, its fat and its potential calories, it can offer 56·7 grams (two ounces) of carbohydrate. No wonder the dietitians urge us to consume more milk.

True Economy in Food.—As regards the results of investigating the cost of calories as purchased in different foods, we may sum up that an *economical dietary must be based upon cereals and cereal products, the pulses, dried fruit, potatoes and onions, butter and suet, milk, cheese and bacon. Moderate economy only can be found in the meats, while lean fish and eggs are costly and to be considered luxuries. Green vegetables and fruits from the calorie point of view are also expensive, but, as they supply some of the vitamins and the neces-*

sary salts, they are essential, and small quantities, despite the calorie cost, must be included in the diet.

A Subsistence Diet.—Continuing our consideration of the cost of the protein and the calorie ration, we can proceed to calculate the minimal cost of a diet which could conceivably keep a human being alive if he could withstand the monotony of it. This diet would be the ideal diet for a governing body of some prison, workhouse or almshouse, were they of a cheese-paring nature.

First of all we must choose the cheapest source of animal protein ration. This, as we have already seen, is the fresh herring, at $2\frac{3}{4}d.$ the ration. Other cheap, but not as cheap sources, are kippers and New Zealand cheese at $3\frac{1}{4}d.$ From this amount we can calculate the calories to be obtained from one source of protein. (For the herrings it is 290.) We then proceed to make up the deficit in calories—*i.e.*, 3,000 — 290 = 2,710—from some cheap source of calories, *e.g.*, haricot beans, $1\frac{1}{4}d.$, white flour and oatmeal, $1\frac{1}{2}d.$, and white bread $2d.$ Let us choose oatmeal. 1,886 great calories are to be obtained from 1 lb. of oatmeal; therefore 2,710 great calories can be obtained from 2,710 ÷ 1,886, or 1·437 lbs. = 1 lb. 7 oz. The cost of this is approximately $2\frac{1}{4}d.$ Animal protein, calories, roughage and salts have been supplied; we have to consider the vitamins. Probably 4 oz. cabbage will supply

the necessary ration. We must now proceed to sum up the analysis of this diet to see if it supplies the requisite total amount of protein, fat and carbohydrate. Here is the analysis [1]:—

	Protein.	Fat.	Carbohydrate.	Calories.	Cost.
	Grams.	Grams.	Grams.		
7¼ oz. fresh herring	30·0	18·0	*Nil.*	290	2¾*d.*
1 lb. 7 oz. oatmeal	77·6	56·1	452	2,693	2¼*d.*
4 oz. cabbage	1·6	0·1	7	36	¾*d.*
Total	109·2	74·2	459	3,019	5¾*d.*

Assuming that anyone could eat so much oatmeal in the day, and could bear the monotony of such a diet week in, week out, it is clear that such a diet would come up to bare physiological requisites. There is enough protein, including animal protein. The fat lies between the normal limits of fat in dietary and so does the carbohydrate. The fish supplies vitamin A, the oatmeal vitamin B, and the cabbage vitamin C. There is calcium, phosphorus, iron, sodium, potassium, and iodine in the diet. There is roughage in the oatmeal and the cabbage. It is conceivable that man could live on this diet at 5¾*d.* a day. Any attempt to make it more interesting,

[1] Analyses from Plimmer.

any variation from it, will cost more. It is the rock-bottom diet.

From its cost we can calculate the minimum cost of food per standard family of a man, wife and three children. Assuming that the wife has the knowledge of calories, etc., to choose this diet, and the capacity to cook it, and the family the endurance to swallow it, and that the family counts as 3·33 adult males (a low estimate) it will cost 1*s.* 7¼*d.* per day, or 11*s.* 2¾*d.* per week. As 66 per cent. of the income of the poorest of the poor goes in food, the rest making up for rent, clothing, warming, lighting and sundries, we see that at present prices the minimum wage would have to be approximately 17*s.* per week. This is the Gradgrind minimum wage, below which physiological maintenance is impossible. Practically it would be impossible at this level, and it is fortunate for society that we do not consider the lowest possible the ideal.

Criticism of a Budget.—Turning to more cheerful topics, we can utilise the tables to criticise the average budget of the average householder. Looking at the budget on p. 141, we see that per adult male this family was obtaining 110 grams protein, 130 grams fat, 408 grams carbohydrates, and 3,430 great calories. The total expenditure was 8*s.* 11¾*d.* at the then ruling prices, and this works out to approximately 9*d.* per 1,000 great calories. There can be little quarrel with the protein ration, and the animal pro-

tein was well above the minimum of 30 grams. The fat and calorie ration are certainly high. But there may be a number of possibilities to account for this: one member of the household slept in the open air, and so would need more calories; the wife was expecting a child in some months' time, and so would also be taking more than usual, and (as is probable) there was a wastage of fat. Counting the family as equivalent to 3·66 adult males to allow for the first two possibilities, the figure per adult male works out to 105 grams protein, 124 grams fat, 390 grams carbohydrate and 3,064 great calories. These are very reasonable figures, and the family can be counted as not taking more than their share of food. For 9*d.* per 1,000 great calories is a very reasonable price to be paying, and the cost of the food works out to about 20 per cent. of the income. For a middle-class family this percentage is approximately normal.

Applying the criterion of cost per 1,000 calories to the working-class budget on p. 143, it was found that this family was spending 5·62*d.* per 1,000. Fifty per cent. more calories were needed, and so the cost of calories should have been cut down to less than 4*d.* per 1,000. At the prices ruling at the time, this meant a restriction to the workhouse or prison dietary discussed on p. 160. At the time, such a dietary cost 8*d.* per adult male per day, or $2\frac{2}{3}d.$ per 1,000 calories, and it would need

to feed a family (such as the one in question), nearly £1 a week. If the cost of 5·62*d.* per 1,000 calories—not a high cost—had been maintained, it would demand an expenditure of about 43*s.* a week, or over two-thirds of the income of this particular family. Three pounds a week was evidently not enough to feed, clothe and house such a family at the time when the budget was collected (1919), unless they were to be restricted to a " workhouse " diet, upon which the continued existence of the family is, to say the least, doubtful.

Calories and Marriage.—Further, it is clear how marriage penalises a man. A bachelor, on £3 per week, may spend at the rate of 1*s.* per 1,000 great calories [1] and yet disburse but 35 per cent. of his income. Clearly the dice are very heavily loaded against the man who assumes the responsibility of a family, and we may, on physiological grounds only, gloomily predict a strike against marriage and birth upon the part of the poor when facts such as those above are realised.

Summary.—In this chapter it is seen how the knowledge acquired by physiologists concerning food may be turned to practical account in regulating the cost of living. All foods are not equally valuable as sources of protein and available calories. The

[1] *I.e.*, a rate as great as that of the professional classes.

costs of the daily ration of animal protein may run as low as $2\frac{3}{4}d.$ or as high as 1*s.* 6*d.* Consequently, it is easy to cut down the cost of food by choosing foods which give the necessary protein rations at a low figure. Similarly with the cost of calories. They may be purchased cheaply at $1\frac{1}{2}d.$ for 1,000 great calories (oatmeal) or dearly at £1 6*s.* 4*d.* (asparagus).

To obtain an economical dietary it is essential to utilise foods which are at the inexpensive ends of each list (see pp. 150—155). The cheapest dietary discoverable is obtained by choosing the cheapest source of animal protein, taking enough of it to yield 30 gram thereof, calculating the calories obtainable from that amount, and then making up the deficit below 3,000 with the cheapest source of calories. These, respectively, even in London, are herrings and oatmeal. Assuming such a diet, monotonous as it is, to be universally possible, we can calculate the irreducible minimum wage per breadwinner. Such a figure is useful to the social economist and the politician.

To the average householder, who would practise economy, the results of physiological investigations are also of value. He knows how many mouths he has to fill and he can calculate the number of calories necessary for them per day. He must determine how much of his income is to go upon food. (For a professional man, 20 per cent. is a reasonable figure.) From this it is simple to calculate how much he may spend, on the average, per 1,000 calories. The tables

given in Appendix I. and the notes in Appendix II. enable him to adjust his dietary to his pocket without danger to his own or his family's health. Perhaps the arithmetic involved will be a little tedious, but it is worth it. No one, in these difficult times, can afford to neglect the discoveries concerning food which have accumulated in the past hundred years. For economy in diet they are of eminently practical importance.

CHAPTER VII

MEALS AND THE ORDER OF THE COURSES

"In the meantime Master Appetite came, and then very orderly sat they down at table."

SO far we have treated the problem of food and the man from a highly soulless and mechanistic point of view. Man has been regarded as nothing better than an animal in quest of repletion. Such was necessary in getting a right orientation to the problem. Fundamentally man *is* an animal in relation to food. The same laws govern him as the animals in his quest for proteins, calories, vitamins and salts. But over and above this animality he has added much. Man is the only animal which has made eating a social function. Think of the lion carrying his kill to his lair and growling and snarling over it. Think of the dog—even so sociable an animal as the dog—retiring to his corner as far away from other dogs as possible and bristling with rage should another approach him. No eagle in his eyrie invites other eagles to the feast. Even the gregarious animals fight for food—*e.g.*, the domestic fowl—if there be any scarcity. So too, doubtless, would cows, sheep, and deer were not their food in such abundance.

Man alone prefers to eat in company, though even so there are traces of the ape and tiger in him. The solitary artisan prefers not to be seen eating, and will choose an obscure spot for his meal where he cannot be overlooked.

Eating, æsthetically regarded, is not a pleasant sight. Yet man has raised an æstheticism on the unæsthetic and brought the appurtenances of a meal and the eating of food to a high art. He expresses himself in his food as much as his food expresses itself in him. The oil of the Italian, the beef of the Briton, the frogs of the French, and the pork of the Prussian are as much symbols of an attitude to life as these races are the outward form and embodiment of those commodities.

Types of Meals.—Meals, when examined for the predominant substances present, may be divided into two types, (i.) carbohydrate and fat, and (ii.) protein and carbohydrate meals. Examples of these are seen in afternoon tea, which consists predominantly of carbohydrate and fat, and in the two-course lunch or dinner, which consist principally of protein and carbohydrate.

Thus bread and butter, jam, toast, and cake consist principally of carbohydrate and fat, while meat, potatoes, vegetables, bread and pudding consist of protein and carbohydrate. For the working classes those two types of meals are the only

types. The *bourgeoisie* adds high tea, a combination of the two types, but the middle and upper classes play variants on the types, but do not depart far from them, even in breakfast, about which a few words will be said later.

For this broad division of meals into these two types there is good reason. Experience has taught us that it pays in the long run, and the physiologist can give an explanation. Meals of one of the three main substances in food at a time have unpleasant and uneconomical results. The most striking are the results of pure fat. None but Esquimaux can consume solid fat. Even animals so omnivorous as the rat cannot deal with a meal of fat. Twenty-four hours after such a meal no less than 60 per cent. of the fat fed is still in the stomach. A similar result is true of dogs and human beings ; moreover, as we have already said, any fat which does go on into the intestine and is there digested and absorbed, results in the unpleasant effect of biliousness due to production of acetone bodies.

The reason of the slow passage of fat from the stomach is due to the fact that it stops the secretion of gastric juice. Gastric juice is acid, and until food is acid it is not allowed to pass through the gateway of the pylorus into the intestine. Much fat in a meal stops the secretion of acid gastric juice, and holds up the food in the stomach, prevents digestion, and starves the cells of the body.

Carbohydrate, on the other hand, leaves the stomach very rapidly. It is very easily acidified and so is allowed to pass through the pylorus. Protein holds an intermediate position. It is the only food which is digested by gastric juice, but it has the capacity of absorbing much acid without becoming acid itself. Until it is acid it is not allowed to pass on into the intestine. Protein, therefore, leaves the stomach more slowly than carbohydrate. So we have very different results, according to whether the meal is predominantly carbohydrate, protein or fat. Carbohydrate can leave the stomach almost at once, protein not for an hour and a half, and fat after a prolonged delay.

Supposing that a meal of bread is taken. This is predominantly carbohydrate and it leaves the stomach in, at the most, an hour and a half. At the end of that time there is a feeling that we are empty and in need of another meal. Who has not had that feeling half-way through the morning after the Continental breakfast of rolls and coffee ? To make a meal of bread at all satisfying we need that it should be retained in the stomach for a longer time, and, to do that, fat in the form of butter is taken. This is the physiological reason for the fat and carbohydrate meal : fat delays the passage of the carbohydrate from the stomach and we feel that we have really had something to eat.

For obvious reasons fat in large quantities should

not be taken with protein. The latter needs acid gastric juice for its digestion. Fat stops the secretion of gastric juice. Consequently, the protein, when mixed with much fat, stays in the stomach in a neutral or alkaline medium and the microbes swallowed with it have their chance of doing their worst. There is the protein to work upon, the warm stomach forms a splendid incubator, there is no acid to kill them, and they can manufacture all sorts of deleterious substances. Here is probably the reason why foods such as pork are so indigestible. All fat meats leave the stomach but slowly, and it is an instinctive desire on the part of people in temperate climates to dilute any fat taken with meat by large amounts of carbohydrate in the form of bread, potatoes and vegetables generally.

We can thus see why the meal which contains much protein should have carbohydrate with it if anything. Protein by itself might be possible. Dogs are delighted with such a meal. But their alimentary tract has been specialised for dealing with a flesh diet. Man is omnivorous. Besides, protein, as we have seen, is expensive, and carbohydrate is the main source of calories in the body. Consequently every meal—breakfast, lunch, tea and dinner—must have carbohydrate in it to enable us to get enough calories.

Meat before Pudding.—But is there any especial

value in the order: meat before pudding? Why should one not take the carbohydrate first and the meat after? There is both a physiological and a psychological reason for this.

The physiological reason is as follows: The stomach consists of two portions: the distant or pyloric end and the near or cardiac end. The pyloric is motile. It spends its time forcibly churning the food to and fro to mix it with gastric juice, to acidify it, partially digest its protein and then to squeeze it through the gates of the pylorus into the intestine. The other end is non-motile. It acts as an elastic bag or reservoir for food, which it gently passes on towards the pyloric end of the stomach when there is room for more food in that part. Food, then, is in an active state of churning motion at the pyloric end; at the cardiac end it is immobile. Further, at the pyloric end it is acidified, the protein digested and the microbes killed; at the cardiac end it remains alkaline, and the saliva is still able to act upon it. There is a ferment in saliva which digests starch, though no other foodstuff, and works only in an alkaline or neutral solution. Acid juice instantly stops its activity.

At once the reason for taking meat before pudding becomes obvious. Saliva has no action on protein, so the meat may as well go straight to the pyloric end of the stomach to be acidified and digested there. In fact, it saves time and digestive juice and trouble

if it does. The pudding, with its excess of carbohydrate, may as well wait in the cardiac end, for the saliva can continue digesting the starch there without interference on the part of the acid gastric juice. This latter only slowly percolates through the quiescent mass of food at the cardiac end.

Supposing that we were to reverse the order and take the pudding first. Then the mobile pyloric end is filled with carbohydrate and the immobile cardiac end with protein mixed with alkaline saliva. The digestion of starch ceases at once in the food in the pyloric end because of the acid of the gastric juice with which it is there mixed. Not much harm is done except that the powers of digestion of starch by saliva are wasted. The acidified pudding is then passed on, quantity by quantity, till it has all left the stomach by about an hour and a half. In the cardiac end, however, we have protein mixed with saliva and being incubated with many swallowed microbes. The saliva can do no good, and the microbes can do their worst for the hour and a half during which they are being incubated. Even if they do not do much harm and the alkaline meat is then passed on to the pylorus, a new evocation of gastric juice is necessary (unaided, as we shall see, by "appetite"), and there will be much delay before the food is passed on to the intestine. It is more economical in time and expenditure of digestive juices if meat precedes pudding than if pudding

precedes meat, besides giving no chance to evil bacteria to spoil the meat in the stomach.

Two exceptions, a minor and a major one, can be adduced to the order of protein before carbohydrate in the larger meals of the day : Yorkshire pudding, in its eponymous county, is eaten before the roast beef, and breakfast usually places cereals (porridge and American breakfast foods) before the fish, eggs or bacon.

It must be remembered that Yorkshire pudding is by no means carbohydrate only. It has the proteins of egg in it, and, having been cooked under the joint, contains much fat. On physiological grounds it must be confessed that to eat it before the meat is a highly improper proceeding. But we must remember that the Yorkshireman is fond of good living and is at the same time thrifty. Possibly the two characteristics coalesce in this fashion of pudding before meat : the pudding fills the portion of the stomach into which meat should go, thus taking the edge off hunger and sparing the more expensive food.

For the order of the breakfast, physiological reasons can be given. The body has been fasting for twelve hours and has depleted its stores of carbohydrate and the rest. As all muscular energy ultimately depends upon carbohydrate, it would appear wise to put an easily digested carbohydrate early in the meal, so that it may pass rapidly through the pylorus, be digested in the small intestine and absorbed into

the blood stream. Porridge will pass through the pylorus rapidly. It contains (or should contain) no large particles ; it has been well cooked and possibly is partially digested before it leaves the stomach ; it can be rapidly acidified in the pyloric end of the stomach, and, having no lumps in it, which would close the pylorus, can easily pass through that gateway into the small intestine. The remainder of the meal stays behind in the stomach to be duly digested, and provides the sense of satisfaction which no breakfasts except the British and American give.

Appetite and Hunger.—To understand the physiological reason for the order of courses at a banquet, a brief discussion of appetite and hunger is necessary. That one's state of mind influences the state of the body is to-day a commonplace. There is, undoubtedly, an interaction between mind and body. It is doubtful if you can have a sound mind in an unsound body, and certainly an unsound mind makes the body unsound. The average contented man has a good digestion ; it is the reformer, the world-weaned Titan, struggling with the forces of reaction, who is dyspeptic and *difficile.*[1]

Now, appetite and hunger are different aspects of the need for food. They are by no means *the same*

[1] "On the Red-blood she [Nature] heaps her favours ; she gives him a good digestion, a clear complexion, and sound nerves. But to the Mollycoddle she apportions dyspepsia and black bile."—"Appearances," G. Lowes Dickinson.

thing, though often confused. Hunger is determined by the state of the body—its need for calories and structural material. Appetite is psychological, it belongs to the realms of desire. In separating them thus it is not intended that they do not interact. Hunger certainly sharpens appetite. But that they are distinct can be seen on a moment's thought. Hunger may drive a starving person to eat things for which he cannot possibly have an appetite, *e.g.*, sawdust, rats and worse. Appetite drives a fully fed person to eat long after the claims of hunger have been satisfied. An Alderman, after a city banquet, still has room for dessert. No one can suggest that he is hungry; but he has an appetite for a luscious pineapple.

Psychic Flow of Gastric Juice.—Now, it is appetite which causes the flow of saliva and to a great extent the flow of gastric juice.[1] When appetite is sharpened by hunger, the flow of the former, saliva,

[1] The facts that appetite evokes a secretion of gastric juice can be utilised by two classes of dyspeptics: those with normally too little secretion and those with too much. Unfortunately there is a close resemblance between the symptoms of each state, and the lay person cannot hope to disentangle them. A medical man must decide. The former should take the foods they like, to increase the activity of the gastric glands, the latter the foods they dislike to act as depressants.

It is a good rule that a man digests best the food he likes, but there are exceptions. The man who suffers distress after food because his stomach is too active in secretion should eat things for which he has no liking. He digests best, or rather suffers least from, the food he dislikes!

becomes at times embarrassing. We know from observations on both dogs and human beings, that the taste and smell of good food causes a copious secretion. Sometimes an accident—for instance, with a gun, in the famous case of Alexis St. Martin, a French-Canadian backwoodsman—makes an artificial opening between the stomach and the outside world through the wall of the abdomen. Sometimes the surgeon has to make such an opening because the gullet has been blocked by a growth or an accident. What is going on in the stomach of such people can be observed with considerable accuracy. A food they like causes a good flow of gastric juice; but one they dislike causes no response, and this, too, even if the food is merely chewed in the mouth and never goes into the stomach at all. Obviously, part of the flow of gastric juice is determined by one's appetite for food, and this flow may be fairly termed the "psychic flow" or the "appetite juice."

As might be expected, any mental state, anxiety, fear or worry, for instance, which upsets the appetite, also upsets the flow of gastric juice. This is partly why the Red-blood, the man of action, who does what is to be done without reflection, is rarely dyspeptic, while the sensitive, brooding Mollycoddle, who ponders life and its meaning and fears it, suffers from indigestion. For him, no good digestion waits upon appetite, for he has none.

Anything that awakens appetite will awaken a

psychic flow of gastric juice when food is eaten. Prime among the things which awaken appetite is hunger.

Flavour and Appetite.—Next is flavour of food, and those with poor appetite are too often accustomed to flavour their food with pungent sauces. In the manufacturing towns of the north, bottles of peppery and acid sauces are on every restaurant table, and in London, too, their presence is by no means rare. The poor of this country use far too many a condiment. They cannot " fancy " their food without it. Elementary school teachers under the London County Council report that their pupils, when asked how they would lay out a certain sum on food, suggest fried fish and pickles as their ideal meal. Poor and ill-ventilated homes, overwork, and too little exercise in the open air, destroy appetite and cause a demand for violent flavours to stimulate it again into being. So, too, do late hours, over-excitement and tropical heat. Hence the need which the night-club frequenter feels for the pick-me-up of hot anchovies on toast, and the Indian colonel for devilled kidneys and curry. To preserve appetite we must live more as the widow of the Nonne Preestes Tale, who never needed a " deal " of " poignant sauce."

Appetite Juice.—The flow of appetite juice depends on a nervous reflex. By the term " reflex " we mean

an adjustment on the part of the body to a change in the environment ; and a nervous reflex is such an adjustment brought about through the agency of the nervous system. Such a nervous reflex needs a sensory organ for the change of the environment to play upon ; a sensory nerve to carry the message to the central nervous system (brain and spinal cord) ; a connection between the sensory nerve and the motor nerve called the "synapse" ; a motor nerve and a responsive organ. The sensory end-organs of the reflex which calls out appetite juice are the olfactory nerve ending (which react to odours), and the taste buds of the tongue. The synapses lie within the brain, and the vagus nerve is the motor (in this case secreto-motor) nerve to the glands of the stomach, the responsive organ.

The synapses are the delicate links in the chain, or arc, which produces the reflex. It is easy to interrupt the discharge across the synapse. Fatigue products, poisons from the large intestine, psychological interference from higher centres of the brain, may all break the connexion and the flow of appetite juice fails. This means that, if for any reason we are "below par," either due to worry, anxiety, or fatigue of mind or body, the secretion of gastric juice will be impaired. The mechanism is tricky and complicated and the wonder is that under modern conditions it so rarely goes completely wrong.

The Order of the Banquet.—Bearing the need of appetite for good digestion in mind, we can see why at a banquet the proceedings begin with *hors-d'œuvre* of varied piquancy. Their function is to stimulate appetite and start the flow of gastric juice. We also see why we need to conclude with a savoury. Hunger has been appeased. Perhaps even the stomach has been overfilled and there is not sufficient gastric juice to digest its contents. The savoury will awake another flow of "appetite" or "psychic" juice. The same is true of the pleasantly acid fruits of the dessert. Fruit is little more than flavoured water. and so needs no gastric juice to digest it. But it can awake a psychic flow of juice and is therefore placed at the end of a large meal when extra gastric juice, but no extra work for it to do, is needed.

Three of the courses of a banquet, then, meet a distinct physiological need, and the order, protein first and then carbohydrates, in the major courses is fixed. So too is the position of the soup, not only by international convention, but also by physiological necessity. It was discovered in the early work on gastric secretion that "the appetite juice" ceased after the important nerve, the vagus, to the stomach was cut. When this nerve is destroyed, by no manner of nervous means can the "psychic flow" be stimulated.

Soups.—None the less, a flow can be started by

means of *chemical* stimulants, chief among which are meat juices, *e.g.* extract of meat, soups, beef tea. These awaken the glands of the stomach to activity even if the nerves are sluggish in action or destroyed.

It has long been known that such extracts are valueless in producing material for the body to burn or to supply energy. Their discoverer and patenter, Liebig, always maintained that they possessed no food value. The "strength" of meat does not go out into the extract, and though the flavouring essences of an ox might be concentrated into a breakfast cup, the protein could not be so concentrated. The body-building power of beef remains in the stringy, tasteless stuff which is left after the "goodness," the flavouring essences, have been removed. Whence, then, comes the universal belief in the value of beef tea? It is stimulating and warming, but so are other things, such as tea, coffee and cocoa. Moreover, it has one drawback. The substances which can be extracted from meat give rise to uric acid in the body and are absolutely contra-indicated when there is any trouble with the excretion of uric acid. None the less, they are held in great public esteem.

The explanation seems to lie in their power to awaken the stomach to activity even in the absence of any "psychic flow." True, they taste nice, and so will evoke a psychic flow in the normal person; but

supposing a man has been ill or worried about business, etc., and the psychic flow has been depressed or abolished. None the less, meat extract will cause a flow of gastric juice after it has entered the stomach, which flow may be called the "chemical flow." There are other substances, *e.g.*, partially digested foods, which will cause a chemical flow, but none are so convenient in use as meat extracts or soups. Since, however, the soup can yield no reasonable amount of calories to the body, it should always be followed by a protein meal upon which the gastric juices evoked by the soup can work. This is supplied by the fish or meat which immediately follow the soup in the international banquet. It is best to follow the soup with fish, for it supplies proteins only, or in predominant amount, and not fat, which would check the secretion of more juice. The fish can be partially digested in the pyloric end of the stomach and still further evoke activity on the part of the secretory glands.

The position of the soup in the meal is thus determined physiologically. The *hors-d'œuvres* are to stimulate a psychic flow of juice; the soup follows to stimulate a chemical flow of juice. Thereafter, having ensured by both means a good flow of gastric juice, we can proceed to load in proteins (as fish and meat), upon which the ferment and acid of the gastric juice may work. Later follow the carbohydrates, which take their place in the cardiac end of the

stomach, to be digested by saliva, and finally the savoury and dessert to provoke a further psychic flow to meet any grave demand for digestive ferment and acid. Thus the whole gamut of the courses of a banquet can be justified from a physiological standpoint. The æsthetics of the meal run parallel with physiological need.

Whether, of course, we need these artificial aids to gastric secretion is open to question. In an ideal state of affairs, the stomach should do its work without artificial stimulus. Hunger and appetite should be there to evoke an adequate secretion. An open-air life, impossible for most of us who live and work in towns, would supply all the necessary stimulus to the flow of gastric juice without the help of "poignant sauce," of *hors-d'œuvres*, soup, savoury and dessert. It is interesting to note that of all nations the British are most willing to do without soup. The Germans, the French, the Austrians, the Russians and even the Americans, look upon soup as a *sine qua non* of a lunch or dinner, while the Chileans specialise in soups. Clearly these nations need this stimulus to gastric secretion. The open-air and exercise-loving Briton can usually dispense with their aid, and it is all to the good.

Drink.—The same is true of the drinks served. As has already been said, alcohol is a poison. Its possible physiological advantages have to be

weighed against this disadvantage. But if we accept the banquet as a reasonable social convention, or even the large six-course dinner, it is difficult to see how it can be sat through unaccompanied by alcohol. Alcohol is a narcotic, not a stimulant. True, people are gayer after alcohol, as if it were stimulating them to originality and even brilliance. As a matter of fact, it is agreed that alcohol removes the normal control exercised by the higher centres of the brain. These are partially paralysed and the more normal man appears. Often this is a gay and irresponsible person, not "sicklied o'er by the pale cast of thought." Certainly alcohol abolishes worry, which is why some people take it to excess. Alcohol may, then, be conceived to have a function at a large meal in abolishing care and so removing one of the causes of a lack of psychic flow of gastric juice and preventing the boredom which would otherwise accompany a prolonged session at table, and stop gastric secretion.

The Aperitif.—The glass of sherry (or even the cocktail) receives some justification. Supposing that a man comes home tired from his office in that state of mind when the daily anxieties of business pursue him into his home. He will have no appetite for a meal because of his fatigue and worry. The aperitif of a sherry or a cocktail will put him in that frame of mind when business affairs will cease to worry, and his "appetite juice" will flow. Explorers have been

known to make use of this fact, for the time of all times for quarrels is just after the tent is pitched for the night and the evening meal is about to be taken. At such a time alcohol may prevent an open rupture and the failure of the expedition. We can explain St. Paul's famous advice to Timothy—to take a little wine for his stomach's sake—on these grounds. Reading between the lines, we can see that Timothy was an over-anxious person, and it may be that Paul's advice was fully justified by modern physiological research.

Hock, Claret and Port.—The later wines of a meal can also be similarly justified. With the meat courses an acid wine such as hock or claret is served. Digestion of meat proceeds only in an acid medium, and on that account an acid wine is of value ; later, in the sweeter courses, an acid wine would be unphysiological, and we can then move on to port. Even the coffee and liqueur at the close of the meal can be justified on physiological grounds.

Motility of the Alimentary Tract.—So far we have made but little mention of the fact that the stomach and intestines are, during the whole of digestion, in a state of great motility. The pyloric end churns the food to and fro by means of waves of contraction, which start from the junction of the cardiac or fundus portion of the stomach with the pyloric end.

These run in orderly procession to the closed pylorus, so that the food is carried along with them and then forcibly squirted back towards the fundus. The function of these waves of contraction is intimately to mix the food with the gastric juice and cause digestion of the proteins and absorption by the walls of the stomach of the chemical stimulants which evoke further secretion of gastric juice.

Similar but more complicated movements take place in the small intestine. There is a segmentation process which squeezes the food to and fro ; a peristalis which sweeps it along ; and a vermicular movement which keeps the intestine literally writhing throughout life. These result in the mixing of food with digestive juices and the absorption of the products of digestion through the walls of the intestine. So efficient an organ is this that by six hours after a large meal much of the digested material has reached the far end of the small intestine—22 feet in length—and the larger proportion (say 90 to 97 per cent.) of the valuable amino acids, glycerine, and the simple sugars (glucose, fructose and galactose) is absorbed.

These gastric and intestinal movements are absolutely essential to digestion. Without them the food lies stagnant within the alimentary tract, prey to every microbe which may get at it. There is lack of hunger and appetite, although the body is not receiving its due amount of nutriment. Often the

stomach is dilated, with consequent embarrassment of the heart.

Influence of Nerves on Motility.—The movements, though capable of continuing even when the nerve supply to the walls of the stomach and intestine is destroyed, are under the control of the nervous system. As is so frequently the case, the control is dual. One set of nerves increases the activity of the movements; the other decreases it. Those nerves which decrease or abolish the movements are nerves arising from the sympathetic nervous system. This is essentially a part of the nervous system which governs secretion of glands and movements of the muscle which is not under control of the will. Thus if the sympathetic system is in a state of activity, the pupil of the eye dilates, the eyes protrude, the skin blanches, the hair stands on end (goose flesh), the mouth parches, there is a cold perspiration, the heart beats violently, and the stomach and intestines cease their activity. All these symptoms of the action of the sympathetic are those of terror, and all but one can be found in the description of a person in a state of terror in a sensational novel. The sympathetic system plays upon the muscle of the iris of the eye and dilates the pupil; it contracts the muscle in the wall of the arteries and so stops the blood supply to the skin; it contracts the muscle at the roots of the hairs and erects them; it stimu-

lates the heart to greater activity and it checks the activity of the muscle in the walls of the stomach and intestines. It is this last activity which interests us in discussing digestion. For adequate digestion the sympathetic system must remain quiescent.

Glands and Motility.—Moreover, there is a gland close to the kidney, called the suprarenal gland, which is under the control of the sympathetic. This gland, when aroused, pours out a substance called adrenaline into the blood stream, and this substance has the power of acting exactly like the sympathetic nervous system. Doubtless this twofold mechanism is to prevent the sympathetic system's being tired out. The adrenaline comes along some seconds after the first effect of the sympathetic stimulation has taken place and continues and reinforces it.

On the other hand, the nerves which excite greater activity on the stomach and intestines belong to a group of nerves called the parasympathetic. Their activity is often closely associated with pleasurable emotions, though not so closely as is the action of the sympathetic with unpleasant emotions, such as fear, rage and anxiety.

Exercise and Motility.—While the movements of the stomach and intestines are aided by mild exercise, strenuous exercise abolishes them. A vigorous

game of fives or tennis is not the wisest prologue to a heavy meal; nor can any but the young start again after it with impunity. To come in overtired to a meal, or to begin again on some heavy muscular task after it, is a sure way of promoting indigestion. A half-hour's rest before and after the big meals of the day is the rule for any dyspeptic.

Influence of Emotion on Digestion.—That emotional states influence the rate of digestion is undoubted. Beaumont, as long ago as 1830, described in his observations on Alexis St. Martin, that on one occasion food remained a phenomenally long time in the stomach. This was subsequent to one of the violent outbursts of temper not, apparently, uncommon in that French Canadian. In more recent times the movements of the stomach of a cat have been seen suddenly to cease when the cat became angry or frightened. The sight of a dog instantly caused a cessation of gastric motility. Sometimes human beings, whose gastric movements are being studied by means of Röntgen rays, have shown cessation of stomach movements in moments of fear. In one case a stomach was seen to lose tone, sag and drop about 4 inches. The patient, on being asked what was the matter, admitted to having been suddenly seized by anxiety. Such a state of mind is inimical to digestion.

The bearing of these facts upon the circumstances

of meal times is obvious. Health waits upon good digestion, and good digestion upon appetite. It is wise " very orderly " to sit down at table. The very ceremony—unless there be women squabbling about precedence—of marching into the dining-room and taking one's place in an orderly manner will break the chain of untoward reflexes. In a truly religious household the grace before meat will do the same and still the inhibitions caused by irritation. Pleasant foods, glass, cutlery and napery, and tasteful table decorations have all their value in driving away dyspepsia and promoting eupepsia.

Anger and Dyspepsia.—Meal-times, and especially breakfast, with its morning's post, the beginnings of business and household worries, and the problematic catching of trains, are notoriously the occasion for the family quarrel. Then is practically the only time when the family assemble and meet together and when a quarrel can be really successful. But it is the time when quarrels are the least satisfactory. They breed indigestion, and the indigestion more quarrels, so that there is a vicious circle set up of dyspepsia and ill-humour.

It has not, however, necessitated all this research in physiology to prove the fact that emotional states interfere with digestion. In the footnote on p. 175, Mr. Lowes Dickinson is quoted as realising that for himself without the aid of the physiologist. Shak-

spere, in a well-known passage, contrasts the psychology of the lean man, whose food "does him no good," with that of the fat man. St. Paul, in his advice to Timothy, too, had come to the same conclusion. But even a thousand years [1] before someone had said: "Better is a dinner of herbs where love is, than a stalled ox and hatred therewith. Better is a dry morsel and quietness therewith, than an house full of feasting with strife." Clearly here is an undoubted recognition of the evil effects on digestion of painful emotion. If it be that the Book of Proverbs was collected by Solomon, it throws an interesting and pathetic light on his domestic life, and gives the chance to the cynic to ask who better should know of the disastrous results of the family quarrel at meal-times than Solomon, that much-married man? For the best enjoyment of a meal we need "The Spur of Cheese" and other stimulants to appetite; together with "The Trivet of Good Thoughts" and "The Kettle of Magnanimity."

Summary.—Eating is a social act in man. The conventional division of meals into two types—carbohydrates and fat, and proteins followed by carbohydrates—has a physiological basis. So has the order of the courses of a banquet. Appetite is essential to good digestion and so are the motor

[1] Higher criticism puts the Book of Proverbs at a date of 200 B.C. But the proverbs themselves are of much more ancient origin.

activities of stomach and intestine. Fatigue and unpleasant emotion destroy appetite and motility of the alimentary tract; whereas good health and pleasurable emotion stimulate both. Consequently pleasant surroundings, good company and cheer aid digestion, and gloom, boring companions and bad food induce dyspepsia.

CHAPTER VIII

THE DANGERS OF MODERN FOODSTUFFS

"Man of God, there is death in the pot."

WE have already seen that restriction of diet to a few articles of food is dangerous, and should only be employed by people who know what they are about. As to the choice of foods, what we nowadays have is much greater than that of our forefathers, and the season of each good thing is much extended. In home produce, horticultural research has much extended the season of food plants; hardy types have been evolved, and vegetables introduced of which our ancestors never heard. From abroad we get things to eat which originally all had to come from the immediate neighbourhood—butter from Ireland, Denmark, Siberia, Australia, and New Zealand; cheese from Canada and New Zealand; meat from Australia, New Zealand and the Argentine. Importation of fruits from overseas has much extended the season, *e.g.*, we get oranges from the Mediterranean, Florida, California and the Cape. Especially does the Cape fruit come at a welcome time, when that from the Northern Hemi-

sphere is over. We have to-day a greater abundance of things from which to choose—if we could only choose them.

Restricted Choice of Foods.—Our choice, however, is restricted partly owing to the time necessary to prepare food, partly to the need for economy, and partly to the increasing difficulty of the "servant problem." The three causes are interwoven. Women who have learnt to earn their living are not so domesticated and do not spend the time in the kitchen and still-room that their grandmothers spent. The need for economy since the War is so urgent—no professional man with £1,000 can hope to send his sons to a public school and one of the older universities—that the expenditure on food has to be cut down severely. The advice in an older edition of Mrs. Beeton, when making a cake, to take half-a-dozen eggs, fills the modern housewife with despair. The virtual disappearance of reliable household help will result—as it has resulted in the U.S.A. and Canada—in our living more and more on ready-cooked and preserved foods, and more and more in hotels and boarding-houses. Such a tendency will deprive us of vitamins, and the consumption of canned goods brings other troubles in its train, as we shall see later.

Sophistication of Foods.—To-day the manufacturer,

to make his foodstuffs keep, or to make them more presentable and palatable, sophisticates them in various ways. Wholemeal does not keep as well as white flour, and so presumably does not lend itself so readily to "manipulation." Besides, the public demands white flour. So the bran is carefully removed and the resulting flour bleached chemically. How far this deprives it of food value can only be guessed. Presumably the starch and protein are not much altered; but we have learnt that the little things of diet are often as important as the great.

Some butter is to-day "renovated," though more commonly in the United States and Germany than in this country. It comes from a distance, and time and storage allow it to go rancid. Such rancid butter is, however, marketed. It is melted and "rendered," thoroughly washed in a melted state, air is blown through to remove the unpleasant odour of rancidity, and the resulting fat churned with milk to which some milk-souring microbe has been added. Such "renovated" butter is indistinguishable, chemically, from ordinary butter. But we can wager that it has lost some of its vitamin A by oxidation. Some of the processes of sophistication do not matter so much from a physiological point of view. If the public likes its beer, butter and jam brought up to a definite standard of colour, this is not objectionable, so long as

the colour is innocuous. (Colleagues of the writer discovered an " egg-powder," *i.e.*, cornflour to which a yellow colouring matter has been added, which contained quantities of lead chromate to give it its " eggy " tint. How many people had been poisoned by this egg-powder is not ascertainable. Lead is a cumulative poison and the egg-powder had been on the market for years.)

Nor perhaps does it matter, from the point of view of health, that strawberry and other jam guaranteed to be made from the ripe, fresh fruit, contains a quantity of rhubarb or other juices from cheap fruits, except that the public is being mildly defrauded, any more than it matters that Cambridgeshire sends large quantities of gooseberry juice to Champagne !

Centralisation of Markets.—The centralisation of our marketing of food, however, entails a number of processes for food to undergo, which may or may not be dangerous. There is the addition of preservatives, such as boric acid and formaldehyde. The former (used in cream) is objectionable, and the maximum amount allowed is carefully specified in Government regulations. Recently a committee appointed by the Government has condemned the use of formaldehyde as dangerous to health, but for the time being it will presumably continue to be used. There is pasteurisation of milk. This process consists in

subjecting the milk to a temperature of 60° C. for 30 minutes. The milk-souring microbes are destroyed and the milk keeps better. But the spores of numerous pathogenic (disease-producing) microbes are left untouched. They may grow and render the milk infectious or toxic, with no other microbes, such as the acid-producing microbes, to keep them down in numbers and innocuous. In fact, pasteurised milk might be, though perfectly good to taste, absolutely deadly. Besides which, pasteurisation destroys some of the vitamin C, and a subsequent heating (as, for instance, in making up infant food or puddings) will destroy the remainder. Pasteurisation is not all the blessing it was thought to be—except to the wholesale merchant—and 60 per cent. of London's milk is pasteurised.

Cold Storage and its Evils.—The carriage of food—meat, poultry and game—from a distance, and the centralisation of the markets, entail cold storage—often for a great length of time. It is said that every egg in the United States goes into cold storage for a year before it is "released." How far cold storage alters foods is not known. It certainly alters the flavour, and most things which have been so stored taste alike. This, as we have seen, alters the value of the food to man, because flavour is of value in provoking a flow of digestive juices. Further, we know from work by one of the writer's colleagues that

the carnosine[1] content of mutton and beef falls in cold storage to about a third of its value. There is evidence from the carnosine content of chilled beef that it has been in cold storage anything up to nine months. If carnosine is so altered, how can we be sure that the beef is not altered in other respects? We cannot trust that no other change of importance in digestion and assimilation of cold-storage food has not been brought about. So far we do not know, and those who can afford it should keep to home-killed meat and run the extra risks of other trouble (see below) which this entails.

Dangers of Preserved Food.[2]—Finally, we have the process of sterilisation and "tinning" and putting up the food products in tins, glass jars and bottles. We know that the sterilisation of lime-juice destroys whatever vitamin C content it may have had, as our Indian Army and Arctic and Antarctic explorers have found to their cost. We know that the canning of meat and vegetables destroys the vitamins B and

[1] Carnosine is a white crystalline substance easily dissolved by water and occurring in most of the meat we eat. Its importance is still unknown.

[2] This paragraph has been criticised by a friend in the preserved food business as unduly harsh. In this chapter on the dangers of modern food it is surely unnecessary to stress the virtues of preserved foods. They are doubtless an enormous boon to the world, but bring dangers in their train. It is only by being harsh about the dangers that people, producers and consumers alike, can be trained to avoid them.

C in those foods—tomatoes being, fortunately, a remarkable exception. Besides, canning opens the door to sundry microbes, which produce virulent poisons, as we shall see in a subsequent paragraph.

Spread of Disease by Food.—One result of the centralisation of our food-supplies and the distribution of them over a wide area is seen in the spreading of disease by foods. These would, under older methods of sale, have spread their effects over a more circumscribed area. In 1922, for instance, infected ice-cream poisoned a number of people within a considerable distance of High Wycombe. Shrimps caught at Gravesend and sold at Tonbridge and Billingshurst poisoned people at the latter place. They became infected on the way. In another place potted meat, made in a factory infested with flies, broadcast disease over a wide area. In the days when the supply of foods had not been so commercialised and centralised this would have been impossible.

Originally the dairy farmer disposed of his milk in his neighbourhood, and it was consumed soon after the cows were milked. Now he may send it 200 miles to London to be consumed thirty-six hours later. It may be infected at the source in dirty cowsheds, by unwashed hands of milkers, and by dirty milk cans ; or on the way by rail, especially at the great termini, where the contents are pooled in dirty sheds carpeted

with horse droppings, or, finally, on its rounds through the streets, where it is uncovered at every house and receives its quota of microbes from the dust of the town streets. As a matter of fact, contamination at the source with tuberculosis, and diseases such as typhoid and scarlet fever are perhaps of more importance than the contamination *en route* with dirt, unpleasant as the latter may be.

Similarly with meat. If the butcher kills and sells his meat in his own area he will be in greater danger of losing his custom as the result of selling diseased meat than if it goes away to Smithfield. It is a fact which should wound our British *amour propre* to know that proportionally ten times more meat of home produce is condemned as unfit for food at Smithfield than of foreign-killed meat. Clearly, thorough inspection of our slaughterhouses is a thing not yet understood in Great Britain. Through the centralisation of our meat and food supply we run a greater danger of poisoning by food unfit for consumption.

Unfitness of Food not Measured by its Odour.—Now, it must not be thought that the unfitness for consumption is measured by the decomposition of the meat. The theory that poisoning by meat is due to putrefaction of the meat and the consequent formation of ptomaines is untenable. It is true that meat in an advanced state of decomposition contains chemical

substances grouped under the term "ptomaines," and that these are highly poisonous when *injected* into the blood stream. Taken by the mouth, however, they are harmless, much as snake venom is harmless when swallowed. Highly decomposed meat may have no ill-effects if eaten. On the other hand, food with no perceptible taint of decomposition may contain a poison of great virulence produced by microbes. These microbes fall into two classes, of which the former is of much more frequent occurrence and leads to much more trouble.

The first class belongs to the group of microbes which contains the paratyphoid microbes. As they were first investigated by Gaertner, it is usual to speak of them as the Gaertner bacilli,[1] though the first one isolated was named *Bacillus enteritidis*. Another of the group, *Bacillus Aertrycke*, is responsible for food poisoning, such as the High Wycombe case mentioned above.

Men and Animals as Microbe Carriers.—These bacilli are not found in the normal human or animal intestine nor in normal meat. They obtain their hold on foodstuffs through the intermediation of man or animals suffering from disease of the intestines due to the microbes in question. Thus the animal may be suffering from the disease due to Gaertner bacilli

[1] Also known as the Salmonella group after Salmon, who discovered the *Bacillus suipestifer*, one of the group.

at the time it is slaughtered, and in the process of preparing the meat for the market infection of the meat by microbic contents of the intestine may easily occur. The microbes grow on the meat and produce the poisons there. Cooking, though it may kill the microbes—they die at a temperature of 70° C.—does not necessarily destroy the poisons, so that, though you may not contract the disease from eating the meat, you may easily be poisoned by the toxins already manufactured.

Then, too, the microbes may be handed on by carriers. Men or animals which have had the disease and recovered from it may have their alimentary tracts still infected with the microbes. (Typhoid, scarlet fever and cerebro-spinal meningitis carriers are a commonplace of medicine to-day.) This infection may last for some time after a man has returned to work, and give a chance for the infection of the meat he handles. The juices of meat and the gelatin used as a filling for pork pies or for brawn form an admirable growth medium for these microbes. They grow and flourish in it and manufacture their poisons. Even though the meat and gelatin be cooked, the poisons are not destroyed, and go forth from the market or factory in the insidious garb of a sausage, meat pie, brawn, or ordinary joint of meat to slay their thousands.

Nor is man the only suspected carrier. Rats and mice may be responsible for the infection, especially

as some of the rat poisons on the market consist largely of microbes of the Gaertner type. Before the rats succumb to the disease, or perhaps after they have recovered from it, they may traverse the meat in warehouse or factory and contaminate it. Finally, flies come under suspicion. Their natural birthplace and haunts are almost unmentionable. A little imagination will show how easily they may transfer the microbes from the alimentary tract of a diseased man or animal to the meat in the slaughterhouse, market or shop. One of the food-poisoning epidemics of 1923 was attributed to the carrier agency of flies.

Other foods besides meat can act as growing grounds for the Gaertner microbes. Milk, cream, ice-cream, potatoes, pineapple jelly and tinned peaches have all been implicated, but the majority of cases are due to meat in the form of pork, ham, beef, brawn, sausages, meat pies, tinned meat and various pickled organs. Mutton is rarely implicated.

Botulism.—The other source of food poisoning is due to the microbe, *Bacillus botulinus*. This much more deadly cause of poisoning is fortunately much rarer, but has been brought vividly before our notice by the fatal mischance at Loch Maree in the summer of 1922. Here eight people on holiday at a hotel partook of sandwiches made from a jar of " wild duck " paste, and all died within three or four days. From

the symptoms and the investigation of the rest of the paste and an uneaten sandwich, the poisoning was undoubtedly due to the toxin manufactured by *Bacillus botulinus*. Truly, there was death in *that* pot.

The *Bacillus botulinus* was discovered nearly twenty years ago in Germany lurking in sausage (whence its name), and has been known to produce havoc in America. Its first known invasion of Great Britain was in the Loch Maree outbreak. It is a tender microbe and itself easily destroyed by heat. Moreover, it grows only out of contact with the air. But it forms spores which can resist the temperature of boiling water, so that if the spores find their way into a German sausage, meat pastes, tinned fruits or vegetables, they can germinate and grow in the airless spaces of the container and secrete their deadly poisons (toxins).

Fortunately, the toxin of *Bacillus botulinus* is destroyed by heat, and a suspicious container can have its contents rendered innocuous by cooking. An odour of rancid butter should arouse suspicion.

Prevention of Food Poisoning.—The prevention of food poisoning would be simple if the public were awake to the danger and its causes. Insistence on inspection of meat and cleanliness and inspection of factories where brawns, meat pastes, etc., are manufactured is sufficient. (Cleanliness is to include the

personal hygiene of the workers and the screening of the factory from flies, as well as the removal of all sources of infection within an area around the factory.) Botulism (poisoning by the toxins of *Bacillus botulinus*) could be prevented by high-temperature sterilisation of the food and the containers when food is tinned—it should be " meticulously jarred "—or, if that would damage the foods, by cooking subsequent to the opening of the container.

The Danger of Patent Foods.—One last danger of modern foodstuffs to be considered is that of the patent foods. I mean no wholesale condemnation of them; there are patent foods which are admirable and there are others the sale of which appears to the writer as obtaining money under false pretences. This is an age of advertisement, and it is fairly safe to say that no matter what the nature of a commodity is, the public can be bludgeoned, at any rate for a time, into using it, by wholesale advertisement. The mass of the public are so suggestible that they can easily be persuaded that black is white, and the newness or costliness of a patent concoction will produce a psychological effect of " feeling better " after they have taken it which has no basis in objective fact. The public are not, and, as a whole, cannot be educated in the analysis of food, but some simple tests, easily made by anyone, can prove some

foods bad for the purpose for which they are advertised. To take an example, a food may be advertised as excellent for a child from the second day of its existence. All medical opinion agrees that a child should have no starch in an artificial food until it is at least six months of age. Iodine, when added to starch, gives an intense blue-black coloration. One drop of the tincture of iodine usually found in the modern household added to a commercial baby food may prove it to be totally unsuitable for infant consumption. Yet sundry such are on the market and widely advertised as having medical support and useful for children from birth. It is no exaggeration to say that there is death in that pot. Nor is it unreasonable to ask that manufacturers be compelled to print on each container of a patent food the approximate composition of the food and its suitability to different ages and states of health. Any patent food should pass the gauntlet of expert medical opinion and not be foisted off on a credulous public by ignorant and commercially-minded manufacturers.

Summary.—All restriction of diet to a few articles of food is folly. Modern conditions tend towards such a restriction. Moreover, the food supplied to-day is often sophisticated so that it becomes dangerous to health. Storage, pasteurisation and sterilisation deprive food of its valuable properties. Inadequate

inspection of foodstuffs and factories results in the wholesale spread of disease, and the very methods of preserving food open the doors to still more disastrous results. Patent foods frequently are useless and even dangerous for the very purposes for which they are advocated.

In view of all this, what are we to do ? We cannot escape the dangers of modern foodstuffs by avoiding them. We must frankly face the horrors of commercialisation of our food supply. They are one of the prices to be paid for civilisation. The disadvantages must be weighed against the advantages, and if possible the disadvantages obviated. A partial remedy is the spread of the allotment and the procuring of fresh fruits and vegetables. But the main remedy lies in eternal vigilance, research, and the broadcasting of the results of research. It is the function of the scientific researcher in diet and of the Government to test the effects of the food of the populace and from time to time to make the public aware of the results of their research. Civilisation is a tentative experiment and only by continued examination, checking and controlling of its effects can it be made a success.

CHAPTER IX

SOME FOODS CONSIDERED

"Milk and broun breed. . . .
Bacoun and somtyme an ey or tweye."

IN this chapter the food values of a number of common foodstuffs will be discussed and their values as sources of the various desiderata of a diet considered.

Bread.—Naturally the first which claims attention is bread, the so-called "staff of life." Probably it gets that name because every class in society eats so much of it, and because the poor find in it their mainstay. The best that we can say for bread, of any sort or description, is that, as a source of calories, it is cheap. That is why the poor eat it. Further, its flavour, such as it is, is one of which the palate does not easily tire. Bread dilutes the stronger flavours of meat and cheese, and it has an agreeable texture. Whether brown or white, it contains vitamin B. These are the sum total of its good qualities. Otherwise it is a poor food *except in conjunction with other foods.* Alone, it has too little and too poor protein. Animals grow but slowly upon it, and the stunted growth of the slum child is

probably in part due to the poverty of building material in bread. There is no vitamin A nor vitamin C in it, and it leaves an acid ash. Therefore it needs to be fortified by animal protein (meat, fish, milk or eggs); by fat (preferably containing vitamin A, *e.g.*, butter); by fruit and vegetables for basic mineral substances and vitamin C. White bread contains no roughage.

Nor is brown bread much to be preferred above white. It has a cleaning effect on the teeth, wherefore dentists recommend it above white; it contains roughage—too much for some people; and it has more vitamin B than white bread. Probably its proteins are a little better,[1] for the male rat asserts his right to a greater stature than the female upon brown bread, upon white he cannot. In these slight superiorities over white there is no basis for the agitation to prevent the use of roller-milled and screened flour which some enthusiasts are raising. Used as a source of calories in a good mixed diet, with meat, milk, vegetables and fruit, there is no reason to discard white bread. Only, perhaps, when the choice of foods is severely restricted by economy, and bread has to be relied upon as the main source of energy, should brown bread be necessarily preferred to white. Otherwise the decision between the two may be left to fancy.

[1] They are, however, not so well absorbed as those of the white bread.

The above paragraphs are not intended to imply that bread should be ousted from the foods we buy. It is excellent—as an adjunct to other foods. Bread, cheese and a tomato form together an admirable physiological meal. By itself it is second rate.

Butter.—Butter is used as a source of (i.) fat and (ii.) vitamin A. There are negligible traces of protein and vitamin B in it. As a fat it is digestible over and above other fats, and is a good source of calories. In fact, it is reasonably inexpensive as a source of calories, and may be purchased by even poor people without any extravagance. The $\frac{1}{2}$ lb. per head per week of the middle-class household (1*s.* for 1,705 calories) looks well against the $\frac{1}{2}$ lb. of meat per head per *day* (9*d.* to 1*s.* for 500 calories). In fact, there is an absurd idea abroad that butter is a thing upon which it is wise to economise. A much more insidious drain upon the purse is meat. The only caution needed about butter from the physiologist's point of view is that it, like all fats, needs balancing by carbohydrates.

heese.—There is no escape from the belief that cheese is one of the most nutritious of foods. A pound of Cheddar cheese contains all the casein and fat of a gallon of milk. Twenty pounds of cheese is said to contain as much food as the 60-lb. carcase of a sheep. The protein of cheese is first-

class animal protein, hardly inferior to that of beef. Moreover, cheese is an economical food standing well to the front for cheapness of animal protein and calorie rations. Cheddar costs about two-thirds of the price of English meat, both for animal protein and calories, and imported cheese is proportionately cheaper. National economy demands that milk and cheese be made in preference to beef, for it costs much less to turn pasturage and cattle feed generally into milk and cheese than into beef. It behoves all good people who wield the Geddes axe of economy to sing the praises of cheese.

Cheese has but few drawbacks. First, it consists of protein, fat (containing vitamin A), and little else but water. It is, therefore, not a " perfect food," a drawback it shares with every other food, and notably with meat. Carbohydrate is needed to balance the fat and prevent its producing ketosis.[1] It contains negligible amounts of vitamins B and C and roughage. But, in conjunction with bread and vegetables or fruit, it forms a perfect diet.

Second, cheese is reputed to be indigestible. For this there is a certain amount of evidence. The fat of cheese protects the protein from the immediate action of the digestive juices and so renders it not easily dealt with by a delicate digestion. Clearly cheese should be in a fine state of division—it should be chewed well—before it reaches the stomach. Or

[1] See p. 70.

it may be served in conjunction with milk, macaroni, spaghetti, etc. Part of its reputation for indigestibility is due to our custom of taking it at the end of a meal which already has contained protein. The cheese remains in the fundus of the stomach and "repeats." So would any strongly flavoured food in a similar position in a meal. Those who take cheese should take it not as a spur to appetite at the end of the meal, but in the position of the *pièce de résistance*.

Third, cheese has occasionally been the source of food poisoning, and for the same reason that meat, milk, and vegetables at times become poisonous: infection with microbes which manufacture a virulent poison.

Cheese, in spite of these drawbacks, can be recommended to those of sound digestions as wholesome, nutritious, economical, and containing good protein, fat, vitamin A and mineral matter.

Eggs.—Adulation of eggs is absurd. Someone has even applied—a doubtful compliment—the following to them :—

> "Treasure-houses, wherein lie,
> Locked by angel's alchemy
> Milk and hair and blood and bone."

Were they, like dukes in King Goodheart's days, three a penny, their praises would be sung by every writer on food. But they are extremely dear, and should be left to millionaires, invalids and children.

Their advantages are good protein, good fat, vitamins A and B, phosphorus, iron, calcium and absence of purin bodies. Their disadvantages are that the white, when uncooked, causes diarrhœa in some persons, but above all, that they are costly. The protein ration costs, when eggs are cheapest, 8*d*. per day, and when dearest, 1*s*. 4*d*.; while to yield 1,000 calories you have to spend from 2*s*. 2*d*. to 4*s*. 4*d*., according to the season. Eggs would begin to be reasonable as food at 1*d*. each, and really worth while at twenty-four for 1*s*. Most of the advantages of eggs can be obtained by utilising other foods: good protein and fat from milk, vitamins A and B from milk, butter, vegetables and fruit; phosphorus from milk; iron and calcium from green vegetables. Unless used sparingly, eggs are a wasteful way of purchasing food.

Fish.—When discussing the food value of fish, it is well to classify them according to their chemical composition. They fall roughly into two groups, the fat and the lean. The lean comprise brill, cod, haddock, sole, whiting; while the fat comprise eels, halibut, herrings, mackerel, salmon, sardines, sprats and tunny. Turbot is intermediate with about 4 per cent. of fat in its flesh. The fat content of fish determines to a large extent their value (i.) to the lean purse, and (ii.) in their content of vitamin A.

Fish are valuable as a source of protein, vitamin A

and iodine, but, with few exceptions, are not economical foods. True the cheaper ones may be economical when used in small amounts for supplying animal protein. Whether this is of the highest standard is not yet known. The physique of Alaskan tribes who take fish as their sole source of animal protein is not as good as that of those who take meat in addition. The cheapest source of animal protein on the market is fresh herring, cod following it at some distance at double the price.

From the calorie point of view, fish are extravagant, with the one exception of herrings, and should be purchased by the rich only. They may be twice or three times as expensive as the best English meat! And the price of fish on the market is no guide to their nutritive value. Thus cod at 1*s.* 2*d.* per pound yields 220 calories, while salmon yields 660. Salmon at 3*s.* 6*d.* per pound is just as cheap as cod.

The value of fish as brain foods and aphrodisiacs is based on mythological evidence only.

The examination of fish as food materials is very damaging to their reputation. Other foods can supply everything which may be obtained from fish, usually at a much cheaper rate. The one exception to these strictures is herring.

Fruit. — Most fresh fruits are little more than flavoured water. As sources of protein and fat, they are ludicrous. But little better claim can be made

for them as sources of carbohydrate. Their calorie value per pound is about that of the lean fish, so that there is little to be said for them on that score.

Their merits are (i.) they stimulate appetite and the flow of "appetite" juice; (ii.) they contain vitamins B and C—a few contain A; (iii.) they contain some mineral matter and yield a basic ash; and (iv.) they supply roughage. Crisp fruit, such as the apple, is useful in cleaning the teeth, and is therefore highly recommended as the conclusion to a meal by dentists.

The following is a list of some common fruits and their products, with their vitamin contents represented by + signs. A ? means experiments not yet carried out or incomplete.

	Vitamin A.	Vitamin B.	Vitamin C.
Apple	?	+	+
Banana	+	Doubtful	+
Grape	?	Low	Very low
Grape-fruit	?	+	+++
Lemon	?	+	+++
Lime juice	Doubtful	+	++
,, Commercial	?	?	0 to +
Orange juice	+ (low)	+	+++
Pear	?	+ (low)	?
Pineapple	?	?	++
Raspberry juice	?	?	+
Tomato	++	+++	+++

It will be seen from this list that fruits are chiefly of value as a source of vitamin C, though tomatoes are an admirable source of A, B and C. Grapes are practically useless. So, too, are dried fruits. They have, however, very considerable value as a cheap source of calories and as supplying roughage.

Meat.—Meat is chiefly of value as a source of animal protein and fat containing vitamin A. For the animal protein ration, meat is dearer than herrings, cheese, mackerel and cod, though for calories it is considerably cheaper than fish (with the usual exception of herrings). But its costs for both protein ration and calories are not so high as to render it inadvisable even on the tables of the poor. It is however, wise to use it in moderation and to substitute cheese and milk for it wherever possible. This is true from the points of view of individual and national economy, as explained above.

The idea that meat promotes energy above all foods is a myth that lingers on. Possibly the myth has its roots in some old folk lore, for the scientific ground, if there ever was any for it, disappeared years ago.

Of the different meats, beef is the most digestible (both as regards its protein and fat), mutton comes next—but this may be due to the high melting-point of its fat—and pork last. Probably this is because the fibres of pork are intimately mixed with fat.

Salting pork apparently makes it more digestible, so that boiled ham and bacon can be tolerated by delicate digestions. Pork fat, as fat, is more digestible than mutton fat. Veal has the reputation of being less digestible than beef, a reputation hotly contested on the continent of Europe.

From the point of view of economy, mutton is the cheapest meat, with pork next. Bacon, however, is cheaper than either, and of the breakfast dishes is undoubtedly the cheapest of all.

That there is any essential difference, beyond these enumerated, between the meats is doubtful, in spite of the experience of Kean, the actor, who ate pork when he was to take the *rôle* of a tyrant, beef when a murderer, and mutton when—a lover!

Meat, and especially meat pies, potted meats and sausages made from meat, are the chief cause of food poisoning. This is perhaps their chief drawback, but it could be obviated by better inspection of the meat at slaughterhouses, etc.

Meat extracts are of no value except as flavourings, stimulants and excitants of the flow of gastric juice, As they contain substances which give rise to uric acid in the body, they (and all meats) are contra-indicated in gout.

To sum up: meats are dear foods; they could be partly or wholly replaced by cheese and milk, but are so firmly established by convention that they will never be ousted from the ordinary person's menu.

Milk.—Milk was intended by nature for the immature animal; but man has stolen his heritage. It is nature's nearest approach to the perfect food. Milk contains good protein, fat, carbohydrate, mineral matter (except iron), and vitamins A, B and C in reasonable amounts. Its ash is alkaline. The drawbacks to milk are (i.) the absence of iron; (ii.) of roughage; (iii.) its high content of water; (iv.) the bacterial infection to which, under modern conditions, it is so liable. The last two can be obviated. Milk need not be drunk as such, but can be eaten in cakes and puddings, or it may form the basis of soups. Better control of the production of milk, inspection and education will do much to prevent the sale of milk which in a saner country would be accounted fit only to be turned into buttons. Milk is reasonable in cost both as protein ration and for calories, and there should be every encouragement to the increase of its use. Great Britain takes far less milk per head than any other great nation. A much-increased consumption of good clean milk in childhood would do much to increase the stature and improve the health, strength and teeth of the nation. Unless the cleanliness of the source of milk is assured, it is better to cook it before consumption.

Vegetables.—So great is the range of types and nature of vegetables that it is difficult to sum up their advantages and disadvantages in a few paragraphs.

Their chief value in diet is that they supply mineral matter (the ash is basic), roughage and vitamins. For proteins [1] and fats they are negligible. Some—potatoes, carrots, beetroots, parsnips, artichokes and onions—have considerable amounts of carbohydrates present, so that they are of some value for calorie production. This is borne out (i.) by the cost of calories, as shown on p. 154, and (ii.) by the diet of poverty-stricken peasants, *e.g.*, the Irish. The dried pulses, peas and beans, yield an enormous amount of energy and so are inexpensive. On the whole, however, vegetables have little value as sources of energy, and it would be very expensive to trust to them alone for calorie value. As stated above, they are chiefly used for bulk and roughage, basic ash and mineral matter and vitamins. Fresh vegetables should on no account be omitted from the diet, and, as regards vitamin C, it is well to assure that some vegetable products be used, especially during the winter, uncooked as salads. In this country there is little fear of their being contaminated by sewage, though on the Continent, and particularly in southern Italy, it is well to avoid uncooked salads and to rely on fruits for vitamin C.

The table on p. 220 gives the vitamin content of some common vegetables.

It will be seen that vegetables are a good source of vitamin B, uncooked vegetables and salads

[1] Peas and beans are exceptions.

	Vitamin A.	Vitamin B.	Vitamin C.
Asparagus. .	?	+++	?
Beet. . .	Low	+	?
Cabbage :			
Raw and green	++	++	+++
Raw and white	0	?	+++
Cooked . .	++	++	0 to + Depending on length of cooking, etc.
Carrots (cooked)	++	++	+
Cauliflower (cooked)	?	?	+
Celery . .	?	+++	?
Dandelion. .	?	?	+
Endive . .	?	?	+
Lettuce . .	++	+++	++
Onion . .	0	++	+
Parsnips . .	Low	?	?
Pickled cabbage.	?	?	0
Potato :			
Cooked 15 min.	?	+	++
Cooked 1 hour.	?	+	+
Runner bean .	++	?	++ Less if cooked.
Spinach (fresh) .	++	++	0 to + Depending on cooking.
Swede juice .	Very low	++	+++ Less if cooked.
Turnip tops .	?	?	+ Less if cooked.
Dried vegetables	?	?	0

excellent for vitamin C, but not so good if cooked. The moral of this is : eat more salad, especially in winter-time, though it is difficult to obtain. Cheap salad can be made from finely shredded cabbage. It is greatly used and appreciated in Canada and the northern parts of the U.S.A.

APPENDIX I

PERCENTAGE COMPOSITION OF COMMON FOODSTUFFS AND COST OF 1,000 CALORIES AND ANIMAL PROTEIN RATION.

(The majority of the prices were obtained from the Army and Navy Co-operative Stores in November, 1924.)

Food.	Waste. Per cent.	Protein. Per cent.	Fat. Per cent.	Carbo-hydrate. Per cent.	Calories. Per pound.	Cost per pound.	Cost per 1,000 calories.	Cost of 30 grams. protein.
Beef:								
Ribs	20·8	13·5	20·0	*Nil.*	1,130	1/6 English. 10*d.* Foreign.	1/4 9*d.*	8¾*d.* 5*d.*
Round (lean)	8·1	18·9	6·9	,,	675	1/8 English. 1/1 Foreign.	2/4½ 1/7½	6½*d.* 4½*d.*
Round (medium)	7·2	18·4	12·2	,,	895	1/8 English. 1/1 Foreign.	2/2¾ 1/5¼	7¼*d.* 4¾*d.*
Round (fat)	12·0	17·0	15·3	,,	1,000	1/8 English. 1/1 Foreign.	1/8 1/1	7¾*d.* 5*d.*
Suet	—	4·6	77·7	,,	3,440	1/6	5¼*d.*	—
Lamb:								
Leg	17·4	15·4	12·9	,,	865	1/6 English. 10½*d.* Foreign.	1/9 1/0½	7¾*d.* 4½*d.*
Shoulder	20·3	14·0	22·4	,,	1,245	1/6 English. 10*d.* Foreign.	1/2½ 8*d.*	8¼*d.* 4¼*d.*
Loin	14·8	15·5	22·9	,,	1,295	1/6 English. 9½*d.* Foreign.	1/2 7¼*d.*	7¾*d.* 4*d.*
Mutton:								
Leg	18·4	14·6	14·0	,,	895	1/6 English. 10½*d.* Foreign.	1/8 11¾*d.*	8¾*d.* 4¾*d.*
Shoulder	22·5	13·3	14·7	,,	900	1/6 English. 10*d.* Foreign.	1/8 11*d.*	9*d.* 5*d.*
Loin	16·0	13·1	26·9	,,	1,420	1/6 English. 11*d.* Foreign.	1/0¾ 7¾*d.*	9*d.* 5½*d.*
Neck	27·4	11·9	17·0	,,	970	1/– English. 5½*d.* Foreign.	1/0¼ 5¾*d.*	6¾*d.* 3*d.*

Food.	Waste. Per cent.	Protein. Per cent.	Fat. Per cent.	Carbo-hydrate. Per cent.	Calories. Per pound.	Cost per pound.	Cost per 1,000 calories.	Cost of 30 grams. protein.
Pork:								
Loin	19·7	13·0	23·0	*Nil.*	1,250	1/6	1/2½	9½*d.*
Leg	10·3	14·3	29·7	,,	1,520	1/4	10½*d.*	7½*d.*
Sm. ham	13·6	13·8	31·7	,,	1,640	2/6	1/6½	1/2½
Sm. bacon	7·7	8·8	59·1	,,	2,720	2/6	11*d.*	1/10½
Fish:								
Cod	29·9	10·8	0·2	,,	225	1/2	5/2	½*d.*
Cod steak	9·2	16·5	0·5	,,	350	1/3	3/7	6*d.*
Haddock	34·7	12·0	0·2	,,	232	9*d.*	3/2¾	5*d.*
Haddock (smoked)	32·2	15·8	0·1	,,	305	1/2	3/10	6*d.*
Halibut	27·8	13·2	0·3	,,	258	2/4	9/0½	1/2
Herring (fresh)	26·0	14·6	8·8	,,	643	6*d.*	9½*d.*	2¾*d.*
Herring (kippered)	25·0	14·1	11·1	,,	730	10*d.*	1/0¾	4½*d.*
Herring (bloater)	21·8	15·3	9·0	,,	662	10*d.*	1/3	4½*d.*
Mackerel	44·7	10·2	4·2	,,	365	7*d.*	1/7½	—
Sole	29·7	13·4	1·3	,,	293	2/–	6/10	1/–
Turbot	43·9	9·4	1·4	,,	234	2/–	8/11	1/5
Dairy Foods:								
Eggs	11·2	11·5	8·8	,,	615	2/8 (8 to 1 lb. at 4*d.* each).	4/4	1/5½
Whole milk	—	3·2	3·8	5·0	310	2½*d.* (7*d.* per quart.)	9*d.*	5½*d.*
Condensed milk	—	8·5	7·9	54·1	1,460	2/9 (two tins).	1/10½	2/1¾
Cheese	—	25·1	32·0	2·4	1,885	1/6	9½*d.*	4¾*d.*
Butter	—	1·0	80·8	—	3,410	2/–	7*d.*	—
Margarine (animal)	—	1·2	78·9	—	3,315	1/–	3½*d.*	—
Margarine (vegetable)	—	1·2	78·9	—	3,315	7*d.*	2¼*d.*	—

APPENDIX I—*continued*

Food.	Waste. Per cent.	Protein. Per cent.	Fat. Per cent.	Carbo-hydrate. Per cent.	Calories. Per pound.	Cost per pound.	Cost per 1,000 calories.
Groceries:							
Cornflour	—	5·0	1·2	77·0	1,650	10*d.*	6½*d.*
Oatmeal	—	13·4	6·6	65·2	1,795	2¾*d.*	1½*d.*
Rice	—	6·5	0·3	76·9	1,610	4*d.*	2½*d.*
Wholemeal	—	10·7	1·7	70·9	1,645	2½*d.*	1½*d.*
White flour	—	10·3	1·4	70·7	1,640	2½*d.*	1½*d.*
White flour (best)	—	8·7	0·9	73·6	1,620	3*d.*	1¾*d.*
Macaroni	—	10·4	0·8	73·0	1,640	4*d.*	2½*d.*
Spaghetti	—	9·4	0·4	75·1	1,640	4*d.*	2½*d.*
Bread (brown)	—	4·2	1·6	46·2	1,035	2½*d.*	2½*d.*
Bread (germ)	—	6·9	1·6	51·3	1,185	3*d.*	2½*d.*
Bread (white)	—	7·1	1·2	52·3	1,195	2½*d.*	2*d.*
Sugar	—	—	—	100·0	1,790	5*d.*	2¾*d.*
Treacle	—	—	—	70·0	1,225	6½*d.*	5½*d.*
Sago	—	1·4	—	78·0	1,665	4½*d.*	2½*d.*
Tapioca	—	0·1	—	88·0	1,685	6*d.*	3½*d.*
Biscuits	—	7·0–12·0	1·0–12·0	66·0–73·0	1,850–1,990	1/4–1/10	8½*d.*–10½*d.*
Dried currants	—	1·9	1·5	67·0	1,315	6*d.*–10*d.*	4½*d.*–7½*d.*
Dried dates	10·0	1·5	2·2	63·6	1,275	4*d.*	3½*d.*
Dried figs	—	3·4	0·3	67·0	1,290	6*d.*	4¾*d.*
Dried raisins	10·0	1·8	2·7	61·8	1,270	9*d.*	7*d.*
Dried prunes	15·0	1·4	—	56·1	1,045	9*d.*–1/2	8½*d.*–1/1½
Vegetables:							
Asparagus	—	1·3	0·2	3·3	95	2/6	26/4
Scarlet runners	7·0	1·7	0·3	7·2	180	—	—
Haricot beans	—	15·8	1·6	59·9	1,530	1¾*d.*	1½*d.*
Beets	20·0	1·0	0·1	7·4	160	3*d.*	1/6¾
Cabbage	15·0	1·1	0·2	4·7	115	3*d.*	2/2¼
Carrots	20·0	0·8	0·2	7·1	155	2*d.*	1/1
Cauliflower	—	1·3	0·5	4·7	135	4*d.*	2/6
Celery	20·0	0·7	0·1	2·6	65	3*d.*	3/10

APPENDIX I—*continued*

Food.	Waste. Per cent.	Protein. Per cent.	Fat. Per cent.	Carbo-hydrate. Per cent.	Calories. Per pound.	Cost per pound.	Cost per 1,000 calories.
Vegetables:							
Cucumber	15·0	0·5	0·2	2·6	65	6*d.*	7/8½
Lettuce	15·0	0·7	0·2	2·5	70	—	—
Onions	10·0	1·1	0·3	8·6	195	1½*d.*	7½*d.*
Parsnips	20·0	1·0	0·4	10·4	230	1½*d.*	6½*d.*
Peas (dried)	—	17·3	0·9	62·5	1,580	4*d.*	2½*d.*
Peas (green)	45·0	2·7	0·9	9·6	235	—	—
Potatoes	20·0	1·3	0·1	14·2	295	1½*d.*	5*d.*
Radishes	30·0	0·7	0·1	3·9	90	—	—
Rhubarb	40·0	0·3	0·4	2·1	60	—	—
Spinach	—	1·6	0·3	3·2	100	3*d.*	2/6
Tomatoes	—	0·7	0·4	3·8	100	8*d.*	6/8
Turnips	30·0	0·7	0·1	5·5	120	1½*d.*	1/0½
Fruits:							
Apples	25·0	0·3	0·3	9·7	195	5*d.*	2/1¾
Bananas	35·0	0·6	0·4	13·0	265	8*d.*	2/9
Blackberries	—	1·0	0·9	9·9	238	—	—
Cherries	5·0	0·7	0·7	14·4	305	—	—
Currants	?	1·2	—	11·6	230	—	—
Figs (green)	—	1·2	—	17·0	330	—	—
Grapes	25·0	0·8	1·1	13·1	300	1/–	3/4
Bilberries	—	0·5	0·5	14·9	300	—	—
Lemons	30·0	0·5	0·4	5·4	125	3½*d.* (average weight of lemon = 4¾ oz.)	2/4
Oranges	27·0	0·5	0·1	7·6	150	3½*d.*	1/11¼
Pears	10·0	0·4	0·4	11·4	230	—	—
Plums	5·0	0·7	—	17·3	325	—	—
Strawberries	5·0	0·7	0·5	6·4	150	1/–	6/8

APPENDIX II

THE reader who has won through up to this point may be pardoned for asking how far does nutritional research help the harassed housewife to feed her family? In fact, the last chapter but one almost seems to suggest that she had better dispense with food altogether. Scattered up and down the book are pieces of advice based on the findings of physiologists concerned with various foods and food practices. To meet the needs of housewives in a hurry, here are a number of staccato and dogmatic statements, the reasons or prejudices for which are to be found in the various chapters :—

I. It is unwise to rely on any one special food, commercial preparation or drug. An all-round, well-mixed diet is the best for any one but a child under three or a chronic invalid.

II. No food-fad, except lacto-vegetarianism—*i.e.*, a diet of cereals, fruit, vegetables, milk, butter, cheese, and eggs—has any physiological backing. Between the ordinary mixed diet and lacto-vegetarianism there is little to choose. Convenience and convention will usually decide.

III. Food should contain some animal protein

(meat, fish, milk, eggs and cheese), fats (preferably animal), carbohydrates, salts, roughage and vitamins. Appetite is a good, but not infallible guide.

IV. Three thousand great calories are needed per day per sedentary male. Others need food in proportion (see pp. 136–139). Hundred-calorie portions of food should be visualised (see p. 120).

V. The minimum animal protein ration is given (p. 132). No middle-class person who has meat or fish three times a day need worry about obtaining this minimal ration. Nor need he worry about his 3,000-calorie ration. (Nevertheless, no family with less than three pounds a week to spend on food should fail to study the subjects treated in Chapters III. to VI.) No diet based on milk, cheese, butter, cereals, fresh vegetables and salad will fail to cover all the needs of the body for proteins, fats, carbohydrates, salts, roughage and vitamins. It is especially necessary in winter to see that the diet contains sources of vitamins: milk, butter, salads and fruit. For vitamins in winter, watercress, fresh cabbage salad, lemonade, tomatoes and oranges are suggested.

VI. Cheap animal protein rations are found in fresh and preserved herrings, cheese, cod, milk and lean beef. Very cheap for calories are cereals, dried peas and beans, dried fruits, potatoes, onions, BUTTER, suet, MILK and BACON. Moderate economy is found in meat. Eggs and fish (other than herrings)

are expensive luxuries and should be left to the rich, except as an occasional extravagance.

No diet is economical which omits vitamins. A is found in butter, herrings, milk and cheese; B in cereals, vegetables and fruit; C in salads, oranges, lemons and tomatoes.

VII. Everything which makes a meal attractive and interesting promotes digestion. Appetite is the best source, but should be stimulated by fresh air and exercise rather than by strong flavours and alcohol. Unpleasant emotions destroy appetite and digestion. The family quarrel at meal times is taboo.

VIII. Food poisoning is the result of microbic infection, and could be obviated if foods were satisfactorily inspected at the source and during the processes of commercial preparation. Patent foods, except on medical advice, should be thrown into the dustbin. The country and the individual should pay cheerfully for food inspection, analysis, control and research.

Finally, if your diet contains meat, fish, milk, butter, cheese, green vegetables, salad and fruit the whole year round, it is as good as modern research can suggest.

INDEX

Where several page references are given, figures in heavy type denote the principal reference.

Accessory food factors, 93 *et seq.*
  cod liver oil and, 99
  nomenclature, 100
  rickets and, 98
Acetone bodies, 18–20, 70
Acid,
  acetic, xi, 59
  amino, 59 *et seq.*
  amino and vitamin B, 102
  butyric, 68
  carbonic—gas, xi
  citric, xi, xii
  definition of, xi, 86
  glutamic, 60
  phosphoric, 80
  residues in food, 87
  sulphuric, xi
  tartaric, xi
Acidity of blood, 86
Alcohol, 49 *et seq.*, 183, 185
Alkali, xii
Alkaline reserve, 86
Amino acid, 59 *et seq.*
Ammonia, 59, 63
Anæmia, 81
Animal foods, 36 *et seq.*
Anti-keratomalacic vitamin, 100
Anti-neuritic vitamin, 90, 102
Anti-rachitic vitamin, 90, 100
Anti-scorbutic vitamin, 97
Anti-xerophthalmic vitamin, 100
Aperitif, 184
Appendicitis, 20
Appetite, 175, 177, 178
  juice, effect of vagus nerve on, 180
Apples,
  analysis, calorie value, etc., 225
  cost of 1,000 calories, 155
  vitamin C in, 105
Arginine, 60, 62
Artichoke, 72
Asparagus,
  analysis, calorie value, etc., 224
  calorie value of, 112
Asthma, 17

Bacon, 19
  cost of protein ration, 150, 151
  cost of 1,000 calories, 154, 157
Baking powder, xi
Bananas,
  analysis, calorie values, etc., 225
  cost of 1,000 calories, 155
Barker, Ellis, and cancer, 77
Bases, xi, 86
Beans, 57
  green, basic residues of, 87

Beans—*continued*
green, phosphorus in, 85
haricot, analysis, calorie value, etc., 224
haricot, cost of 1,000 calories, 153
scarlet runner, analysis calorie value, etc., 224
scarlet runner, vitamin B in, 103, 220
Beef,
analysis, calorie values, etc., 222
and food poisoning, 203
cost of 1,000 calories, 154
cost of protein ration, 150, 159
fat, xii, 67
protein, 65
tea, 181
Beet,
analysis, calorie value, etc., 224
basic residues of, 87
Beri-beri, 21, 90, 93, 94
distribution of, 97
false theories of, 98
in birds, 98
in Kut, 104
instinct and, 129
possibility of, on poor diets, 104
sleeping and sleepy sickness, confusion with, 97
Bilberries, analysis, calorie value, etc., of, 225
Bile, 20
Biliousness, 70
Biscuits, 19, 73
analysis, calorie value, etc., of, 224
cost of 1,000 calories, 154
vitamin B in, 103
Blackberries, analysis, calorie value, etc., of, 225
Bloaters,
analysis, calorie value, etc., of, 223
cost of 1,000 calories, 154
Blood clot and calcium, 79
Bones, 79, 80
Boric acid, 196
Botulism, 203
Bran, 76
vitamin B in, 103
Brawn and food poisoning, 203
Bread, 22, 27, 32, 43, 56, 70, 208
calorie value of, 112
cost of 1,000 calories, 153
poor in calcium, 85
Bread, brown, 33, 43, 46, 77
analysis, calorie value, etc., of, 224
cost of 1,000 calories, 153
phosphorus in, 85
vitamin B in, 103
Bread, germ, analysis, calorie value, etc., of, 224
Bread, white, 15, 33, 43, 46, 56, 208
analysis, calorie value, etc., of, 224
cost of 1,000 calories, 153
phosphorus in, 85
poor in iron, 85
vitamin B in, 103
Budget,
family energy, 139
food, 141, 142
Butter, xii, 40, 56, 67, 68, 210
analysis, calorie value, etc., of, 223
renovated, 195
vitamin A in, 101, 102
Butyric acid, 68

Cabbage,
analysis, calorie value, etc., of, 224
cost of 1,000 calories, 155
vitamin C in, 105
Calcium, 79
carbonate, 79
fluoride, 79
minimal requirements, 84
phosphate, 79
rickets and, 98
Calorie,
definition of, 111, 112
the hundred, portion, 120, 144
values, tables of, 117, 119, 153–155, 222–225
Calories,
conservation of energy and, 115
cost of, 152 *et seq.*, 222–225
foods, various, and, 112, 146
marriage and, 164
mental work and, 135
physical work and, 135, 136
war and, 113
Calorimeter,
bomb, 114
human, 114
Calorimetry, indirect, 115
Cancer, 44
and Barker, Ellis, 43, 77
and hot food, 44
and toxæmia, 77
Canned foods, vitamin B absent from, 103
Cannibalism, argument for, 64
Carbohydrate, xii, 56, **71**
and fat meal, physiology of, 170
Carrots, 72
basic residues of, 87
calcium in, 85
Carrots—*continued*
calorie value, etc., of, 224
cost of 1,000 calories, 154
vitamin A in, 102, 220
vitamin B in, 103, 220
Caseinogen, 32, 60, 80
Catalysts, 55, 89
Cauliflower, 66
analysis, calorie value, etc., of, 224
calcium in, 85
cost of 1,000 calories, 155
phosphorus in, 85
Celery,
analysis, calorie value, etc., of, 224
calcium in, 85
cost of 1,000 calories, 155
Cellulose, 71, 72, 76
Cereals,
acid residues of, 87
vitamin A, deficient in, 101
Chalk, xi
Cheese, 40, 42, 57, 67, 68, 150, **210**
analysis, calorie value, etc., of, 223
calcium in, 85
cost of protein ration in, 150
cost of 1,000 calories, 154
phosphorus in, 85
residues, basic of, 87
vitamin A in, 101, 102
Cherries, analysis, calorie value, etc., of, 225
Chesterfield, thyroid trouble in, 82
Chloride, sodium, starvation of, 81
Chlorine and chlorides, 81 *et seq.*
minimal requirements, 85

Chlorosis, 81
Cholesterol, 67
Claret, 50, 185
Cod, 19
  analysis, calorie value, etc., of, 223
  cost of protein ration, 150
  cost of 1,000 calories, 155
Cod liver oil,
  rickets and, 99
  vitamin A and, 101
  vitamin A ration, 147
Constipation, 39, 47, 56, 76, 77
Cooking, 44
  and food poisoning, 202, 204
  and vitamin A, 102
  conservative, value of, 87
Cornflour,
  analysis, calorie value, etc., of, 224
  cost of 1,000 calories, 154
Council, Medical Research, 23, 25
Crabs, 75
Crayfish, 75
Cream, 67
  and disease, 202
  vitamin A in, 101
Cretins and iodine, 82
Cucumber,
  analysis, calorie value, etc., of, 225
  cost of 1,000 calories, 155
Culpeper, 81
Currants,
  dried, analysis, calorie value, etc., of, 224
  dried, cost of 1,000 calories, 154
  red, analysis, calorie value, etc., of, 225
Cystine, 60, 63
Dandelion, iron in, 86
Dates, 77
  analysis, calorie value, etc., of, 224
  cost of 1,000 calories, 154
Dairy produce, cost of calories, 156, 223
Derbyshire neck, 21, 82–84
Dextrin, 73
Diabetes, 75
Diet,
  essentials of, 56 *et seq.*
  a subsistence, 160
Digestion, effect of emotion on, 189
Disaccharides, 74
Disease,
  chronic, 150
  deficiency, 20
  spread of, by food, 199
Dried fruits,
  cost of calories, 159
  no vitamin C in, 105
Dried vegetables, no vitamin C in, 105
Drinks
  and weight, 123
  at meals, 47, 183
Duck fat, 67
Dyspepsia, 45, 48
  anger and, 190
  the politician and, 175

Economy, food, 159
Eels, 53
Eggs, 22, 40, 42, 56, 212
  acid residues of, 87
  cost of calorie ration in, 153, 155, 157, 158, 223
  cost of protein ration in, 150, 151, 158
  iron and phosphorus, 85

Egg white, 57, 58
Egg yolk, 28
  calcium, iron and phosphorus in, 85
  vitamin B in, 103
Eiweiss, 57
Emotion and digestion, 16, 177, 185, 187, 189–191
Endocrine organs, 79
Energy, 133
  conservation of, 46, 113
  food and, 54, 55, 109, 155
  ration,
    calculation of family budget and, 139
    children and, 137
    cost of, 153–159
    sex and, 136
    work and, 134, 136
Epsom salts, xi
Experiments
  in nutrition, animal, 27
  scientific, in nutrition, difficulty of, 26
Extractives, 56

Fat, xii, 18, 20, 56, 67 *et seq.*
  and carbohydrate meal, physiology of, 170
  and warmth, 69
  cost of, 71, 146
  effect on gastric secretion of, 169
Fats, calorie value of, 112, 146
Fat-soluble A vitamin, 101, 102
Figs, 77
  dried, analysis, calorie value, etc., of, 224
  dried, cost of 1,000 calories, 154
Figs—*continued*
  green, analysis, calorie value, etc., of, 225
Fire, 43
Fish, 65, 213
  analysis, calorie value, etc., of, 155, 223
  and iodine, 84
  cost of protein ration in, 150 223
  fat, 67
  oily, cost of 1,000 calories, 155
  oily, vitamin A in, 102
  white (or lean), 68
Flavour, 53, 56, 178, 180
Fletcherism, 45
Flies and disease, 203
Flour, white,
  analysis, calorie value, etc., of, 224
  cost of 1,000 calories, 153
Food
  and energy, 54, 55, 109
  and health, 16
  dangers of modern, 193
  definition of, 53, 54
  economy in, 159
  functions and nature of, 53 *et seq.*
  poisoning, 200
    prevention of, 204
  restricted choice of, 194
Foods, patent, 205
Formaldehyde, 196
Fruit, 56, 214
  analysis, calorie value, etc., of, 225
  effect on scurvy, 97
Fruitarianism, 39, 40

Gaertner bacillus, 201
  in foods, various, 203

Gastric juice,
effect of fat on, 169
psychic flow of, 176
Gastric movements, 186
Gelatine, 60, 66
Glasswort and iodine, 84
Glucose, 74
Glutamic acid, 60
Gluten, 32
Glycerine, 68, 69
Glycogen, 74, 75
God, 26
Goitre, 21
Goose fat, 67
Gradgrind, 162
Grapes, 17
analysis, calorie value, etc., of, 225
cost of 1,000 calories, 155
low content of vitamin C in, 105
Groceries, analysis, calorie value, etc., of, 223
Growth
and food, 54
of children, 15, 23

Haddock,
analysis, calorie value, etc., of, 223
cost of 1,000 calories, 155
Hæmatin, hæmatoporphyrin, 80
Hæmoglobin, 80, 81
and chlorides, 82
Halibut,
analysis, calorie value, etc., of, 223
cost of 1,000 calories, 155
Ham,
analysis, calorie value, etc., of, 223
and food poisoning, 203
Ham—*continued*
cost of protein ration, 150–151
cost of 1,000 calories, 154
Hartwell, xiii
Hay fever, 17
Headache (*see also* "Constipation"), 18, 20
Health, Ministry of, 23
Heart, vitamin B in, 103
Heart-beat and calcium, 79
Heat, source of, in body, 110
Herrings, 19
analysis, calorie value, etc., of, 223
cost of protein ration, 150
cost of 1,000 calories, 154
fat, 67, 68
Histidine, 60, 62
Honey, 19, 73
Hopkins, Sir Gowland, 93, 94, 97, 98, 99
Hunger, 175
Hutchison, xiii

Ice cream and disease, 203
Idiosyncrasies of diet, 17
Iodine, 21, 82–84
minimal requirement of, 85
Iodised salt, 84
Iron, xi, 80, 81
minimal requirement of, 85
Insulin, 75

Jam, 19

Keratomalacia, 100
incidence of, 99
Ketosis, 20
Kippers,
analysis, calorie value, etc., of, 223
cost of 1,000 calories, 154

Lamb,
analysis, calorie value, etc., of, 222
cost of 1,000 calories, 154
Lane, Arbuthnot, 77
Lecithin, 67, 80, 91
Lemonade, 19
vitamin C in, 107
Lemons, xi
analysis, calorie value, etc., of, 225
cost of 1,000 calories, 155
scurvy and, 95
vitamin C in, 105
Lentils, 57
Lettuce, 225
Lime, xi
Limes and lime-juice, 96
Lime-juice, no vitamin C in commercial, 105
Linseed oil, 101
Lipoids, 67
Liver, 75
vitamin B in, 103
fat, vitamin A in, 101
Lobsters, 75
and iodine, 84
Lusk, Dr. Graham, xiii
Lysine, 60, 62, 63

Macaroni,
analysis, calorie value, etc., of, 224
cost of 1,000 calories, 153, 154
Mackerel, 19
analysis, calorie value, etc., of, 223
cost of protein ration in, 150, 151
fat, 67
Magnesia, xi
Magnesium phosphate, 79
Magnesium sulphate, xi
Maize, 66, 67
Margarine,
analysis, calorie value, etc., of, 223
cost of 1,000 calories, 153, 154
vitamin A in, 101
Marmite, vitamin B in, 104, 147
Meals, 167
order of courses of, 180
Meat, 56, 58, 68, 216
analysis, calorie value, etc., of, 222–223
cold storage in relation to, 198
cost of protein ration in, 150
cost of 1,000 calories, 154
fresh, vitamin C in, 105
iron in, 85
phosphorus in, 85
ptomaine and, 200
relation of pudding to, 171
salt, vitamin C in, 105
Meat pies and food poisoning, 203
Medical Research Council, 23
Metchnikoff, 77
Milk, 19, 24, 29, 32, 56, 57, 58, 65, 67, 74, 159, 218
Milk,
analysis, calorie value, etc., of, 112, 223
and disease, 199, 203
basic residues of, 87
calcium in, 85
clot and calcium, 79
condensed, analysis, calorie value, etc., of, 223
cost of protein ration in, 150, 151, 223
cost of 1,000 calories, 154
iron in, 85
pasteurisation of, 196

Milk—*continued*
phosphorus in, 85
vitamin A in, 101, 102
vitamin B in, 103
vitamin C in, 105
vitamin C and pasteurisation of, 106
Mince-pies, 16
Minimal requirements
of calcium, 84
of calories, 133–139
of chlorine, 85
of iodine, 85
of iron, 85
of phosphorus, 85
of protein, 130
of roughage, 123
of salts, 124
of vitamins, 147, 160
Monosaccharides, 74
Morning sickness, 18, 19
Motherhood, 18
Muscatels, 73
Muscles
and calcium, 79
and carbohydrates, 75
and phosphorus, 80
Mussels, 75
Mutton,
analysis, calorie values, etc., of, 222
cost of protein ration, 150
cost of 1,000 calories, 154
rare as cause of food poisoning, 203
fat, xii, 67

Nature, back to, 42 *et seq.*
Nausea, 18
Neck, Derbyshire, 21, 82
Nerves and calcium, 79
Neutral salts, xii
Newman, Sir George, 33
Nitrogen, xii
Nuts, 68

Oatmeal, 77, 175
analysis, calorie value, etc., of, 224
calcium in, 85
cost of 1,000 calories, 153
iron and phosphorus in, 85
salts in, 87
vitamin B in, 103
Oats, 68, 72
Oil,
cod liver, and iodine, 84
cotton seed, 67
maize, 67
olive, xii, 67, 101
Russian, 76
Onions,
analysis, calorie value, etc., of, 225
and iodine, 85
cost of 1,000 calories, 154
scurvy and, 95
Oranges, 95
analysis, calorie value, etc., of, 225
cost of 1,000 calories, 155
vitamin B in, 103
vitamin C in, 105
Ouida, 43
Ovocide, 42 *footnote.*
Oysters, 75, 84

Pancreas, 75
Parathyroids, 80
Parsley, 68
Parsnips, 53
analysis, calorie value, etc., of, 225
basic residues of, 87
cost of 1,000 calories, 154

Pasteurisation, 196
Pears,
  analysis, calorie value, etc., of, 225
  vitamin B in, 103
Peas, 57
  dried, analysis, calorie value, etc., of, 225
  dried, cost, of 1,000 calories, 154
  green, analysis, calorie value, etc., of, 225
  green, iron and phosphorus in, 85
Pellagra, 21, 22
Phenylalanine, 60, 63
Phosphorus, 80
  bones and, 80
  lecithin and, 80
  minimal requirements, 85
  teeth and, 80
Plaice, 19
Pneumonia and chlorides, 81
Polyneuritis (*see also* "Beri-beri"), 98
Polysaccharides, 74
Pork,
  analysis, calorie value, etc., of, 222
  and food poisoning, 203
  cost of protein ration, 150, 151
  cost of 1,000 calories, 154
  fat, 67
Potato, 65, 68, 72
  analysis, calorie value, etc., of, 112, 225
  cost of 1,000 calories, 154
  disease and, 203
  poor in calcium, 85
  vitamin B in, 103
Pregnancy, 18, 74
Preservatives, 196
Preserved foods, dangers of, 198
Prohibition, 51
Protein, xii, 21, 22, 56, 57 *et seq.*
  biological value, 64 *et seq.*
  heat energy, 69, 115, 116
  ration, 125–130
    low, 128
    minimum, 131
    to estimate, 126
    statistical enquiry, 127
Prunes, 77
  dried, analysis, calorie value, etc., 224
"Ptomaine" poisoning, 39, 199 *et seq.*
Pulses, 57, 72
  as cheap source of calories, 155

Quality of food,
  and growth, 23, 29 *et seq.*
  and price, 17
Quantity of food and growth, 31

Radishes, analysis, calorie value of, 225
Raisins, analysis, calorie value of, 224
Ration,
  the calorie, 152, 153, 154
  the calorie, cost of, 153–155
  the daily, 121
  the daily fluid, 122
  the protein, 124, 150
  the roughage, 123
  the salts, 124
  the vitamin, 147
Rats,
  albino, 27
  rate of growth of, and food, 27
Rennet, 58
Research Council, Medical, 23, 25

Rhubarb, analysis, calorie value, etc., of, 225
Rice, 66, 68
  analysis, calorie value, etc., of, 224
  cost of 1,000 calories, 154
Rickets, 25, 75, 90, 94, 98
  and accessory food factors, 98
  and instinct, 129
Roughage, xiii, 47, 56, **76**, 123

Sago,
  analysis, calorie value, etc., of, 224
  cost of 1,000 calories, 154
Salad, 56, 77
  salts of, 87
Salmon, 19
  fat, 67
Salts, xii, 27, 56, 78 *et seq.*
Salt licks, 82
Sardines, 19
Sausage
  and food poisoning, 203
  bacillus botulinus and, 204
Savoury, 180
Scurvy, 21, 90, **94**
  and instinct, 129
  and institutions, 107
  false theories concerning, 96
  fresh fruit a cure for, 95, 97
  guinea-pig's susceptibility, 97, 105
  vitamin C and, 104
Seaweeds as source of iodine, 84
Shellfish, 17
Sickness,
  green, 81
  morning, 18
Soaps, 68
Sodium chloride, xii
Sole, 19
  analysis, calorie value, etc., of, 223
  cost of 1,000 calories, 155
Soups, 180–183
Spaghetti,
  analysis, calorie value, etc., of, 224
  cost of 1,000 calories, 154
Spinach, 66
  analysis, calorie value, etc., of, 225
  basic residues of, 87
  calcium, iron and phosphorus in, 85
  cost of 1,000 calories, 155
Starch, xii, 18, 70, **71**
  heat energy and, 69
Stomach, exercise and motility, 188
Strawberries, 17
  analysis, calorie value, etc., of, 225
Sugar, xii, 18, 20, 57, 68, 70, 71 **73**
  cane or beet, 73, 74
  cost of 1,000 calories, 154, 224
  grape, 73, 74, 80
  heat energy of, 69
  malt, 72, 74
  milk or sugar of milk, 19, 74
Suprarenal gland, 188
Sweets, 20
Sympathetic nervous system, 187

Tables,
  cost of 1,000 calories, 153–155, 222–225
  cost of protein ration, 150–152

Tables—*continued*
minimum protein ration in terms of food, 132
vitamins in fruit, 215
vitamins in vegetables, 220
Tapioca,
analysis, calorie value, etc., of, 224
cost of 1,000 calories, 154
Teeth, mineral salts of, 79, 80
Thyroid
gland and iodine, 82, 83
secretion and puberty, 83
trouble, distribution of, 83
Thyroxin, 83
Tinned foods
and food poisoning, 203
vitamin B in, 103
vitamin C in, 105
Toast, 19
Tomatoes, 53
analysis, calorie value, etc., of, 225
cost of 1,000 calories, 155
daily vitamin ration in, 147
poor in calcium and iron, 85
vitamin A in, 102
vitamin C in, 105
Toxæmia, 77
Tryptophane, 60, 91
Tuberculosis, 25–26
Turbot,
analysis, calorie value, etc., of, 223
cost of 1,000 calories, 155
Turnips,
analysis, calorie value, etc., of, 225
cost of 1,000 calories, 154
Tyrosine, 60

Unfired food, 43
Uric acid and vegetarianism, 38
Uterus, 18

Vegetable oils, 101
Vegetables, 56, **218**
analysis, calorie value, etc., of, 224
cost of 1,000 calories, 155
effect on scurvy, 97
green, 77
green, basic residues of, 87
green, vitamin A in, 101, 102
Vegetalianism, 39, 41
Vegetarianism, 35 *et seq.*
definition of, 39
salt hunger and, 82
Vegetarians, prominent, 36
Vinegar, xi
Vitamins, xiii, 21, 27, 39, 56, **87**
and vegetables, 155, 220
chemical nature of, 88
Hopkins and, 93
in fruits, table, 215
pioneer work in, 91
Vitamin A, 70, 71, 90, **100**
and cereals, 101
and cooking, 102
and keratomalacia, 100
and rickets, 100
and temperature, 102
sources of, 101, 102
Vitamin B, 90, **102**
and amino acids, 102
and the British diet, 103
and nursing animals, 103
and temperature, 103
distribution of, 103
Vitamin C, 90, **104**
and American Civil War, 106
and moulds on fruit, 106
and oxidation, 106
and pasteurisation of milk, 106

Vitamin C—*continued*
and possibility of lack of, 106
and scurvy, 104
and temperature, 105
distribution of, 105
Vitellin, 80

War, calorie values during, 113, 134
Water, 56
and weight, 123
Watercress, 81
Wear and tear, 54
Wheat, 66, 67, 72
poor in calcium, 85
White flour,
analysis, calorie value, etc., of, 224
cost of 1,000 calories, 153
Whiting, 19
Wholemeal,
analysis, calorie value, etc., of, 224
cost of 1,000 calories, 153
iron in, 85
Working classes, fats and, 146

Yeast, vitamin B in, 103
Yorkshire pudding, 174

Zein, 60, 91

PRINTED IN GREAT BRITAIN BY THE WHITEFRIARS PRESS, LTD.,
LONDON AND TONBRIDGE.